'More Bang for the Buck': Examining the Determinants of Terrorist Adoption of New Weapons Technologies

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Examining the Determinants of Terrorist Adoption of New Weapons Technologies

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Abstract

As modern technologies appear and mature, those concerned with security often fear that these technologies will expand the destructiveness of asymmetric adversaries, terrorists chief among them. Yet, historically, only a small subset of terrorists has been particularly innovative with respect to weapons selection and use. This interdisciplinary study seeks to fill a gap in current research on the topic of terrorist behaviour by examining the dynamics underlying terrorist weapons adoption, with the aim of elucidating the technological and organizational mechanisms behind changes in the instruments of terror.

The study explores the topic from two different theoretical perspectives: the historical adoption of weapons by a variety of actors and terrorist (and more general) organizational innovation. The result is the identification of a complex web of factors that is distilled down to a framework representing a highly contingent interaction between the terrorist organization and the prospective weapon in a particular social, political, and security setting. In order to supplement and provide a preliminary validation of the initial model, the adoption behaviour of four different terrorist organizations is analysed, using pairwise comparison and other techniques.

The cases largely confirm the central theoretical strategic and tactical logic of weapons adoption, as well as highlight the crucial role played by a variety of contingent factors, from ideology to the terrorists' social networks. In so doing, the study challenges notions of technological determinism with respect to terrorists and emerging technologies by identifying several key factors that can confound or facilitate a terrorist group's successful adoption of a new weapon. The insights gained through this study can assist policymakers and practitioners by identifying the technology-organization dyads of greatest concern and introducing a new methodology for discerning between those terrorists that are likely to embrace new technologies of lethality and those that will stumble along the way.

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Chapter 1: Introduction

Man has, it can be said, often excelled at engaging in violent conflict with his fellow man. Over time, his chosen tools for this purpose – weapons – have become increasingly efficient. This dynamic can be illustrated by observing that for several millennia the harm that could be reliably inflicted during a single act of violence by an independent individual or small group was more or less limited to felling one opponent with a blow from a melee weapon, or the launch of a spear or arrow.[1] The invention of gunpowder, followed several hundreds of years later by dynamite, expanded the scale of casualties to the hundreds, whereas the perfidious ploy of turning the enemy's own infrastructures into weapons against him, as on 11 September 2001, elevated the level of destruction into the low thousands. Yet at no previous point in human history has a relatively small and isolated group of adversaries possessed the ability to, on their own, acquire and use a weapon capable of unleashing a single attack that could devastate economies, disrupt the social functions of large areas, or kill and injure hundreds of thousands of human beings.

Modern technologies, however – ranging from synthetic biology to so-called '3D printing' – may very well provide opportunities for creating such asymmetric levels of damage. And when it comes to actors capitalizing on these opportunities, terrorists, who are counted among the foremost practitioners of asymmetric conflict in our time, naturally feature high on the list of concerns. Indeed, if such an unholy union took place between certain sets of technologies and non-state malefactors, it would in some sense 'represent the apogee of the firepower arc and the true "consumerization" ' of mass destruction, in which 'small groups of violent dissenters from the status quo, driven by solipsistic and uncompromising ideologies, become capable of repeatedly unleashing the most devastating weapons known to humanity and are thus able to present themselves as credible rivals to the state's current monopoly on military power'.[2] One

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[1] Arson, poisoning and contamination were not unheard of in antediluvian warfare, but their effects were either circumscribed to a single food or water source or ultimately depended on a fair amount of luck (the presence of dry wood or the assistance of pathogenic microorganisms), making the scale of the harm caused unreliable. Siege engines (such as the ballista, catapult and trebuchet) could inflict more damage, but their acquisition was almost certainly beyond the reach of independent actors, i.e., those unsupported by a larger political entity.

[2] Jeremy Tamsett and Gary Ackerman, 'Conclusion' in Gary Ackerman and Jeremy Tamsett (eds.), *Jihadists and Weapons of Mass Destruction* (Boca Raton, Florida: CRC Press, 2009), pp. 402, 416;

is reminded of the dictum long attributed to that great inventor and mathematician of Ancient Greece, Archimedes. 'Give me a lever long enough and a fulcrum on which to place it', he is alleged to have stated, 'and I shall move the world'. Emerging technology could thus very well be lengthening the lever of terrorism.

In this respect, there have been several broad government pronouncements regarding the danger. For example, the 2002 *National Security Strategy of the United States* maintains that 'The gravest danger our Nation faces lies at *the crossroads of radicalism and technology*. Our enemies have openly declared that they are seeking weapons of mass destruction, and evidence indicates that they are doing so with determination' (emphasis added).[3] On closer examination, however, at least three questionable assumptions are implicit in most such official statements on the topic. The first assumption is that, as technological advances applicable in the domain of irregular warfare emerge, terrorists will necessarily become aware of their potential for new means of causing harm; second, that terrorists and other non-state actors will necessarily seek to employ these developments to gain more destructive capabilities; and third, that their adoption efforts will be successful.

These assumptions are made despite there being very little rigorous, empirically-based discussion, in the scholarly literature or elsewhere, regarding the complex process and decision mechanisms by which terrorists adopt new weapons. If the impact of emerging technologies on terrorists' weapons usage could have such potentially deleterious consequences as those described above, then surely the topic of terrorist weapons adoption should have received close and thorough examination, instead of being somewhat cursorily explored or discussed only as part of more general investigations into such topics as terrorist innovation or learning? In response, this study will attempt to investigate the above assumptions and answer key questions regarding how emerging technologies and other factors might affect the desire and capability of terrorists to adopt new weapons, and thus how a transition to more lethal forms of terrorism might occur.

Chyba and Greninger independently arrived at a similar conclusion in their assessment of advances in biology, referring to the possibility of a ' "banalization" of WMD capacity' (Christopher F. Chyba and Alex L. Greninger, 'Biotechnology and Bioterrorism: An Unprecedented World' in Russell D. Howard and James J.F. Forest (eds.), *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2008), p. 204).

[3] *National Security Strategy of the United States* (Washington, D.C.: White House, September 2002).

Current Scholarly Understanding of Terrorist Weapons Adoption

The existing literature on terrorism often refers to terrorists' selection of weapons but has rarely, if ever, approached the topic of weapons adoption directly, that is, analysing the determinants of adoption pursuit and success at a fundamental level. The terrorist adoption of weapons has primarily been discussed as part of the broader topics of terrorist innovation and learning, which include, *inter alia*, discussion of the adoption of new tactics, strategies, and organizational forms, in addition to new weapons. Even in this wider topic area, there has been astonishingly limited research.[4] Among the most comprehensive efforts in the area of terrorist innovation is the recent work of Adam Dolnik[5] and of Brian Jackson and colleagues at the RAND Corporation.[6]

There are also a handful of texts that purport to focus on the specific relationship between terrorism and technology.[7] With the exception of a single article by Jackson (which is based on his terrorist innovation work cited above),[8] these texts fail to deliver much in the way of detailed investigation into whether and how terrorists adopt new technologies, instead describing broad trends in the terrorist usage of weapons[9] or

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[4] See Adam Dolnik, *Understanding Terrorist Innovation: Technology, tactics and global trends* (New York: Routledge, 2007), p. 10. The most in-depth studies that have been undertaken thus far are Maria J. Rasmussen and Mohamed Hafez (eds.), *Terrorist Innovations in Weapons of Mass Effect: Preconditions, Causes, and Predictive Indicators* (Defense Threat Reduction Agency, Advanced Systems and Concepts Office, Report Number ASCO 2010-019, October 2010), Dolnik, and Brian A. Jackson et al., *Aptitude for Destruction-Vol. 1: Organizational Learning in Terrorist Groups and Its Implications for Combating Terrorism* and *Vol. 2: Case Studies of Organizational Learning in Five Terrorist Groups* (Santa Monica: RAND, 2007). Martha Crenshaw, as usual, was way ahead in this regard with a conference paper delivered in 2000, but this remained unpublished until inclusion in Rasmussen and Hafez. See Martha Crenshaw, 'Innovation: Decision Points in the Trajectory of Terrorism' in Rasmaussen and Hafez (eds.).
[5] Dolnik, *passim*.
[6] See Jackson, et. al. and Kim Cragin, Peter Chalk, Sara A. Daly, Brian A. Jackson, *Sharing the Dragon's Teeth: Terrorist Groups and the Exchange of New Technologies* (Santa Monica: RAND, 2007).
[7] Texts looking specifically at the terrorists and technology include: David Clarke (ed.), *Technology and Terrorism* (Somerset, NJ: Transaction Publishers, 2004); Brian A. Jackson, 'Technology Acquisition by Terrorist Groups: Threat Assessment Informed by Lessons from Private Sector Technology Adoption', *Studies in Conflict and Terrorism*, 24:3 (May 2001); Abraham R. Wagner, 'Terrorist Use of New Technologies' in Peter Katona, Michael D. Intriligator and John P. Sullivan (eds.), *Countering Terrorism and WMD: Creating a Global Counterterrorism Network* (New York: Routledge, 2006); and Paul Wilkinson (ed.), *Terrorism and Technology* (Portland, Oregon: Frank Cass, 1993).
[8] Jackson, 'Technology Acquisition'.
[9] Richard Clutterbuck, 'Trends in Terrorist Weaponry' in Wilkinson (ed.); Brian A. Jackson and David R. Frelinger, *Rifling through the Terrorists' Arsenal: Exploring Groups' Weapon Choices and Technology Strategies* (Santa Monica, CA: RAND, 2007).

casting their net much more broadly into such areas as counterterrorism technologies.

Even the more comprehensive studies of broader terrorist innovation that do not deal solely with the technological aspects, have thus far only touched upon isolated aspects of innovation and have left many unanswered questions that pertain to weapons adoption. For example, Dolnik's excellent foray into this topic identified some potentially important drivers of innovation, but his case studies were unable to provide much insight into several of these.[10] Moreover, much of the existing research seems to be biased towards cases of successful innovation, not to mention the most durable and well-resourced terrorist groups, which can lead to spurious findings.[11] Crucially, because such studies are cast in broader terms than weapons adoption,[12] they also tend to underemphasize the role played by the weapons technology itself and how this interacts with the organizational features of the terrorist group.

One area of terrorism studies that does focus on the weapons technologies themselves is the voluminous literature dealing with terrorist acquisition and use of so-called weapons of mass destruction (WMD), which are usually taken as including nuclear weapons as well as higher-end chemical, biological and radiological weapons (CBRN).[13] For the most part, scholars have adopted a measured approach to analysing the threat of WMD terrorism, providing a welcome antidote to some of the hype circulating in the news media and elsewhere, but in many cases still acknowledging a serious threat. Several commentators have done a commendable job of tabulating the wide variety of incentives and disincentives for using WMD,[14] as well as differentiating between the

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[10] See Dolnik, pp. 173-175. Among his more equivocal results were the impact of intergroup competition (pp. 162-163) and the precise relationship between resources and innovation (p. 164).
[11] Gary Ackerman and John Sawyer, *Embracing Technologies of Lethality* (College Park, Maryland: START, 2012), p. 30. Indeed, of the above-cited studies, only Dolnik examines a case of failed innovation and even then only a single case (pp. 127-145).
[12] One exception is Cragin, et. al., but this examines weapons adoption in a narrow context, i.e., technology transfer between terrorist groups.
[13] The term 'weapons of mass destruction' and its acronym 'WMD', as applied in the context of terrorism, are used in this study to mean: *Chemical, biological, radiological, nuclear and yet-to-appear weapons which, if used, would inflict catastrophic casualties, widespread psychosocial disruption or devastating economic consequences substantially greater than those brought about by the largest non-state actor conventional attacks carried out thus far.* For a detailed exposition of the reasoning behind this definition, in which I have elaborated on the evolution of the term as well as the conceptual and practical problems associated with each of its constituent elements, see Gary Ackerman and Jeremy Tamsett, 'Introduction' in Ackerman and Tamsett (eds.), pp. xix – xxii.
[14] Possibly the most systematic accounting of the various incentives and disincentives for the terrorist use of CBRN weapons can be found in Nadine Gurr and Benjamin Cole, *The New Face of Terrorism: Threats from Weapons of Mass Destruction,* (New York: I. B. Tauris, 2002).

desire to employ WMD on the part of non-state actors and their ability to do so. Indeed, a 2005 survey of the literature found something of a consensus among scholars – backed up by existing empirical evidence – that for the time being WMD would not be the first choice of weapon for most terrorists.[15] Moreover, some progress has been made in the past seven years towards providing more detailed 'second order' analyses of the phenomenon.[16]

Yet, although there is some recognition among scholars of the potential dangers posed by emerging technologies with respect to WMD terrorism,[17] the discourse so far has been superficial in one important respect. While the authors – many of whom are physical or life scientists – pay no small amount of attention to the technologies themselves, the relationship of terrorists and other non-state actors to these technologies as weapons is given short shrift. Consciously or not, the vast majority of discussion in this regard reflects a measure of technological determinism – that just because the technology exists, terrorists will be aware of it, seek to adopt it and successfully integrate it into their violent repertoire in the form of WMD. In short, the WMD terrorism literature appears largely to make the same three assumptions, described above, that are prevalent among policymakers.[18] For example, Thomas Homer-Dixon avers that, 'Little can be done … about terrorists' inexorably rising capacity for violence. This trend results from deep technological forces that can't be stopped without producing major disruptions elsewhere in our economies and societies'.[19] Furthermore,

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[15] See Jeffrey M. Bale and Gary A. Ackerman, 'Profiling the WMD Terrorism Threat', in Stephen M. Maurer (ed.), *WMD Terrorism: Science and Policy Choices* (Cambridge, Massachusetts: MIT Press, 2009).

[16] Gary Ackerman, 'Defining knowledge gaps within CBRN terrorism research', in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), p. 16.

[17] There is surprisingly little mention of future technological developments and how these will affect the potential for WMD terrorism. Among those that have at least mentioned the potential dangers associated with changes in technology and its diffusion to terrorists in general, are Gurr and Cole, p. 41; Magnus Ranstorp and Magnus Normark, 'Introduction' in Ranstorp and Normark (eds.), p. 4; Chyba and Greninger, pp. 204, 198; Raymond Zilinskas and Malcolm Dando, 'Biotechnology and Bioterrorism' in Raymond Zilinskas and Richard Pilch (eds.), *Encyclopedia of Bioterrorism Defense* (Hoboken, New Jersey: John Wiley & Sons, 2005); and Amy E. Smithson, 'Indicators of Chemical Terrorism' in Ranstorp and Normark (eds.), pp. 78-83. Besides a handful of texts considering the dangers of nanotechnology (for example, Toby Shelley, *Nanotechnology: New Promises, New Dangers* (London: Zed Books, 2006)), the only discussion of novel technologies with the potential to become WMD that I have encountered is that of Waller and George (Forest E. Waller, Jr. and Michael A. George, 'Emerging WMD Technologies', in Howard and Forest (eds.)).

[18] One of the few exceptions in this regard is Palfy (Arpad Palfy, 'Weapon System Selection and Mass-Casualty Terrorism', *Terrorism and Political Violence*, 15 (2003)) who, while not touching on the adoption process, goes to great pains to link the decision to use CBRN to strategic and tactical objectives.

[19] Thomas Homer-Dixon, 'The Rise of Complex Terrorism' in Howard and Forest (eds.), p. 41.

this literature focuses almost exclusively on CBRN, leaving the terrorist adoption of the panoply of conventional weapons (not to mention novel exotic weapons systems) untouched.

Overall, these earlier works dealing with terrorists and their acquisition and use of weapons technology provide useful case studies and overviews but little in the way of theory that might be generalized to other contexts. Most importantly, although existing studies – whether of a broader topic like terrorist innovation or a narrower one like terrorist use of WMD – have described some of the factors underlying terrorist weapons selection, none of them have provided a detailed explanation of the *process* by which terrorists make adoption decisions and implement them, which is a central concern of this study. Nor do any of these studies provide a means for incorporating the dynamics associated with rapidly advancing, emerging technology into these selection and adoption processes.

While the existing corpus of literature is on its own insufficient for the current analysis, it can provide a useful starting point for understanding the basis of terrorist weapons adoption, as well as identifying salient contributing factors in this regard (as utilized in Chapter 3).

One of the central observations that does emerge from the literature is a near consensus among scholars that terrorists have traditionally tended to be both conservative and imitative in their use of weapons (and tactics more broadly).[20] Generally speaking, irrespective of the idiosyncrasy of their ideologies and goals, most terrorists most of the time employ the 'path of least resistance'[21] by seeking to use the easiest, most cost effective and reliable methods to accomplish their aims. An example of this conservatism is the encouragement in online jihadist forums to scale down grandiose

[20] Dolnik traces the evolution of terrorist tactics, finds that small arms and explosives have dominated terrorist tactical repertoires (pp. 26, 36) and concludes that 'when one surveys the last 50 years of terrorist operations case by case, very few incidents strike the observer as creative *in any way*' (p.56, emphasis in the original). See, also, Brian Jenkins, 'Defense Against Terrorism', *Political Science Quarterly 101, Reflections on Providing for "The Common Good,"* 101:5 (1986), pp. 777-778; Bruce Hoffman, *Terrorist Targeting: Tactics, Trends, and Potentialities* (Santa Monica, California: RAND 1992), p. 15; Gavin Cameron, *Nuclear Terrorism: A Threat Assessment for the 21st Century* (New York: Macmillan Palgrave, 1999), p. 156.

[21] Gordon Woo, *Understanding Terrorism Risk* (Risk Management Solutions). Accessed at http://www.rms.com/Publications/UnderstandTerRisk_Woo_RiskReport04.pdf, on 1 November 2006, p.7.

attack plans to ones that will have more limited effects, but greater chances of success. One such posting noted that ‘a hand grenade that explodes in one of New York’s streets, is better than a nuclear bomb capable of exploding half of New York that does not explode!’.[22]

At the same time, terrorists have often been observed to be imitative, learning not only from their own experience, but also from myriad other practitioners of violence, be these conventional militaries, transnational criminal organizations or other terrorist groups. It is therefore common for terrorist groups to adopt the perceived successful weapons used by a variety of other actors, albeit with some degree of localization.[23]

The reasons for a baseline of conservative and imitative behaviour with respect to weapons selection are not difficult to discern. First, scholars have observed a general predilection for minimizing the complexity of terrorist operations overall.[24] Second, most terrorists experience ‘the unavoidable constraints of limited resources’[25] and there are costs (including opportunity costs) associated with identifying, researching and implementing new weapons and techniques in terms of time, finances, personnel and so forth.[26] Third, in an operational context of incomplete information[27] there are also often lingering uncertainties about the reliability of any new weapon or tactic in terms of achieving its desired effects.[28] These uncertainties can be minimized, although not completely removed, but only by further costly and often risky processes of testing.[29]

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[22] ‘Urgent message to the blessed jihadi cells’, (in Arabic) thread started by ‘ibn al-tanzim’ on *al-Ekhlas*, 1 July 2007, accessed at www.alekhlaas.net/forum, on 2 July 2007. Cited in Anne Stenersen, ‘Al-Qaeda’s thinking on CBRN’, in Ranstorp and Normark (eds.), p. 59.
[23] For example, Carlos Marighella adapted many of Mao Zedong’s formulae for guerrilla warfare to the urban context (Carlos Marighella, *Minimanual of the Urban Guerrilla* (Montreal: Abraham Guillen Press, 2002 [originally published in 1960]), *passim*).
[24] Palfy describes a ‘relationship between simplicity and success…because terrorist organizations, similar to military units in combat, become vulnerable to factors outside their sphere of control as soon as the mission enters its executions phase’ (Palfy, p. 87).
[25] Paul Wilkinson, ‘Editor’s Introduction: Technology and Terrorism’ in Wilkinson (ed.), p. 4. Important exceptions are Hizb’allah of Lebanon, which reportedly receives in excess of US$100 million per anum in aid from Iran, in addition to other sources of income (Daniel Byman, ‘Iran, Terrorism, and Weapons of Mass Destruction’, *Studies in Conflict & Terrorism*, 31:3 (2008), pp. 172-173) and Aum Shinrikyo, whose assets at one point were estimated to be between $20 million and $1 billion (David E. Kaplan, ‘Aum Shinrikyo (1995)’ in Jonathan Tucker (ed.), *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge, MA: MIT Press, 2000), p. 210).
[26] Stephen Maurer, ‘Technologies of Evil’ in Maurer (ed.), pp. 75-76.
[27] Michael Kenney, *From Pablo to Osama* (University Park, Penn.: Penn State University Press, 2008), p. 104.
[28] Cragin et al., p.13; Charles D. Ferguson, ‘Influence Diagram Analysis of Nuclear and Radiological Terrorism’ in Ranstorp and Normark (eds.), pp. 128-129.
[29] Maurer, pp.75-76.

Not to mention the safety issues present for any personnel involved in acquiring, producing or deploying a weapon that might contain hazardous materials and involve unfamiliar techniques.[30]

Nevertheless, the prime driver of conservatism in terrorist attack modalities is probably the basic lack of an incentive to innovate – much of the time, there are plentiful 'soft' targets available which remain vulnerable to the tried and true methods of the gun and the bomb. This is often true even when the objectives entail substantial numbers of casualties or property damage.

There are, however, exceptions to this generally observed pattern of terrorist imitation and repetition in attack modalities. It is often these very exceptions, whether they reflect an innovation in targeting, command-and-control, or weapons, that prove most costly in terms of lives and economic effects.[31] So, despite their inherent conservatism, many terrorist organizations do adopt new weapons technologies from time to time and a small number of terrorists do so frequently. The sizeable potential consequences of these departures from baseline behaviour in turn behoove researchers to attempt to understand what prompts terrorists to innovate with respect to weapons and how successful they will be in doing so.

While the various precipitants of new weapons adoption will be systematically explored in a later chapter, the following (partial) list of five possible circumstances under which terrorists might embrace new weapons technologies can serve to illustrate why a more in-depth examination of the phenomenon is warranted.

1. *The group or individual possesses a specific ideological or idiosyncratic orientation towards innovating technologically in general or towards a specific high-technology weapon*. This 'techno-fetishism' involves a non-strategic affinity – deriving either from the group's doctrines or from its leaders' personalities or backgrounds – for adopting particular technologies or more broadly embracing technological innovations that can predispose the group to

[30] MacKenzie claims that highly complex systems and technologies can also introduce 'relatively novel hazards' (Donald MacKenzie, *Essays on Technical Change* (Cambridge: MIT Press, 1996), p.209).
[31] A spectacular example is the attacks of 11 September 2001, which many commentators regard as representing a tactical innovation in that simple box-cutters, impeccable coordination, and willingness to commit suicide were used to circumvent existing defences.

pursue novel or technologically advanced weapons. One example is the fascination of Shoko Asahara, the leader of the Japanese cult Aum Shinrikyo, with WMD and other unconventional weapons – he even went so far as to write odes to sarin and to send Aum operatives to archives to explore the documents of Nikola Tesla in the hopes of building an earthquake generating machine.[32] The doctrinal features of other non-state actors may likewise drive members to push the technological envelope in the future, such as a hypothetically violent version of the Raëlian cult, whose members actively pursue human cloning and believe that benign extra-terrestrials will only return when mankind has become sufficiently technologically advanced.

2. *Existing weapons are seen to be incapable of achieving terrorist operational objectives*. When current weapons are perceived by terrorists to be insufficient to cause desired levels of casualties, physical damage, publicity, or psychological impact, an incentive to innovate can be created. One way this can occur is if defensive measures increase in effectiveness:[33] for example, the introduction of metal detectors into American airports in 1973 made it far more difficult to hijack aircraft, and consequently the number of hijackings dropped precipitously.[34] Conversely, this situation might occur if terrorists' operational objectives expand, for example, when a group believes that its attacks no longer attract the same levels of publicity that they used to and conclude that the situation can be remedied by drastically increasing the number of casualties per attack.
3. *Innovation driven by concerns involving status and competition.* Not entirely dissimilar to the previous factor, new weapons might be sought by terrorists who feel the need to distinguish themselves from potential or actual competitor groups or to remain relevant to their envisaged constituency. Much of our modern culture celebrates technological adroitness and adopting novel weapons systems is one means by which a politically astute terrorist group or leadership can preserve or enhance its status.

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[32] Kaplan, p. 212.

[33] Bruce Hoffman, *The Modern Terrorist Mindset: Tactics, Targets, and Technologies* (Scotland: St. Andrews University Centre for the Study of Terrorism and Political Violence, 1997), p. 16; also Dolnik, pp.152, 174.

[34] Laura Dugan, Gary Lafree and Alex Piquero, 'Testing a Rational Choice Model of Airline Hijackings', *Criminology*, Volume 43 (2005), p. 1054.

4. *The group possesses an extremely high level of resources, allowing for extensive weapons research and development programmes*. This refers not only to copious finances, but also to less tangible logistical capabilities, such as well-developed communications and transportation structures, or secure locations where the often lengthy weapons development process can be carried out without interference. The experiences of Hizb'allah and the Provisional Irish Republican Army indicate that large, well-resourced terrorist organizations can possess the latitude to embark on multiple research and development efforts, while continuing to employ traditional weapons.
5. *Costs associated with adopting new technology are lowered*. This is a corollary to the previous factor in that the group's material resources remain the same, but the costs to the group of acquiring and using new weapons systems decrease. This could occur if the group succeeds, either intentionally or unintentionally, in recruiting members with more advanced technical capabilities. It can also occur as a result of broader patterns of technological change. Relevant technological developments could arise from research breakthroughs in specialized institutions such as universities, but are more likely to stem from the maturation of existing advanced technologies, as these technologies transition from basic research into commercially available 'off-the-shelf' applications.

The first noteworthy aspect of the above list is that, although most of these factors have been referred to, either explicitly or implicitly, in the literature, scholars have heretofore not systematically explored how these factors interact with each other and with the baseline conservatism already mentioned. In other words, why in a particular case is the reticence to innovate overcome by a certain threshold of factors and what makes some terrorist groups more likely to tolerate the risks associated with innovation than others? A cohesive understanding of these issues is lacking.

The above list also introduces a concept that will be periodically returned to during the study. This is the idea that the circumstances that might spur the adoption of new weapons reflect two different types of processes: 1) a 'push' dynamic wherein factors internal to the terrorist group lead the group to seek out and pursue innovation in weapons usage, and 2) a 'pull' dynamic, which involves factors in the external environment attracting the terrorists towards weapons innovation. Certain of the listed circumstances may reflect more of one dynamic than the other, although it is likely that most, if not all, adoption circumstances reflect elements of both dynamics.[35]

While this study will examine the entire process of weapons adoption by terrorists, it will focus in its policy-relevant applications on the basic premise that technological change in the wider society can constitute an important component of the pull dynamic associated with terrorist weapons innovation. In so doing, it will therefore specifically attempt to answer key questions regarding how emerging technologies might affect the desire and capability of terrorists and other violent non-state actors to employ new weapons, and thus how a transition to more dangerous incarnations of terrorism might occur.

Research Goals

The above discussion allows me to lay out the objective of the study as follows:

> *Through the use of an interdisciplinary approach, this study seeks to examine the dynamics underlying terrorist weapons adoption, with the aim of elucidating the behavioural, technological and organizational mechanisms behind changes in the instruments of terror. The study further seeks to delineate the policy implications of any identified dynamics and to explore options for minimizing the contribution of technological changes to the threat of terrorism.*

The study will approach the terrorist adoption of new weapons technologies as a process, focusing on three conceptually distinct stages of weapons adoption: 1) *awareness* of a new weapon or a new technology and its potential for use as a weapon; 2) the *decision* whether or not to attempt to adopt the new weapon or technology; and 3) *implementation* of a positive adoption decision. A negative outcome at any stage terminates the process and results in the potential weapon or technology not being adopted. It should be noted that, while many of the same factors might influence more

[35] Also, once new techniques have been learnt and (successfully) used by one terrorist group, the imitative dynamic can also come into play, even across widely disparate groups. For example, the (relatively inefficient) instructions for extracting ricin outlined in al-Qa`ida manuals seem to have been word-for-word translations of similar instructions found in underground right-wing literature in the United States (Jeffrey M. Bale et al., *Ricin Found in London: An al-Qa'ida Connection?* (Monterey, California: Centre for Nonproliferation Studies, January 23, 2003)).

than one stage of the process, they might do so in different ways, whereas other factors might be salient at only one stage. Much of the analysis will therefore treat the component stages of the adoption process separately, with the understanding that a positive outcome must occur at each stage for adoption to be successful.

Signposts and Boundaries

Up to this point, terminology such as 'terrorist' and 'technology' has been used rather loosely, relying on the reader's intuitive understanding of such things, but serious analysis requires precise definition of the concepts under investigation, as well as a demarcation of the scope of inquiry. Since many of the terms as used colloquially are either ambiguous, controversial or downright misleading, clearly defining the terminology involved in the study will itself go a long way toward delimiting the orbit of analysis.

Terrorism[36]

When approaching the definition of terrorism, one must do so with the utmost caution and humility, remaining fully cognizant that there is nothing even remotely resembling a consensus (either within officialdom or academia) on what a terrorist is. This uncertainty has naturally resulted in a multitude of divergent definitions.[37] The significance of the inability of scholars and governments to converge on a more-or-less consistent meaning goes beyond mere academic nit-picking. Since an objective definition of terrorism has proven elusive, the concept has become liable to subjective manipulation by political actors, leading to the aphorism that 'one person's terrorist is another's freedom fighter'. Furthermore, the official definition of terrorism often forms the basis of the political, military, or legal response to it and the lack of a commonly accepted definition can hamper counterterrorism efforts that cut across organizational or national boundaries. The one thing almost everyone agrees on, however, is that the word 'terrorist' bestows a negative connotation – it has thus often become politically

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[36] A modified and abridged version of the first paragraph of this subsection was utilized by the author in Ackerman and Tamsett, pp. xxii-xxiii.
[37] See, for example, the extensive survey of definitions of terrorism in Alex P. Schmid and Albert J. Jongman, *Political Terrorism: A New Guide to Actors, Authors, Concepts, Data Bases, Theories and Literature* (Amsterdam: North-Holland, 1988), especially pp. 1-38 and Bruce Hoffman, *Inside Terrorism* (New York: Columbia University Press, 2006), pp. 1-42.

expedient for governments to label any armed opponent as a terrorist. Acknowledging the definitional morass surrounding terrorism, several 'workarounds' have been attempted, but these are only partial at best and none have proven satisfactory replacements for a universally accepted definition.[38]

The primary function of a constructive definition of terrorism is to allow one to distinguish between terrorism and other forms of violence (such as guerrilla warfare or genocide). The approach adopted here is to formulate a definition around the central observation that terrorism is not dyadic in nature. Almost all other types of violence involve two main types of actor, perpetrator(s) and victim(s). Terrorism, on the other hand, always involves additional actors, namely the audience(s) whose behaviour the terrorists seek to alter. The true targets of terrorist violence are thus, paradoxically, not the immediate victims who are killed or injured, but rather the wider public, the state, the international community, potential recruits, erstwhile state sponsors, or some combination of the above. The immediate victims are thus usually little more than a symbolic mechanism for sending one or more messages (often disseminated by the reflected fear the attack causes) to a wider audience. Terrorism is therefore 'nothing more than a violent technique of psychological manipulation'[39] and, as such, has often been cast in the mould of theatre of the macabre. Further, since terrorism can constitute strategy as well as tactics – and oscillate between these levels of conflict – it is perhaps best characterized as an 'operational posture' adopted by its protagonists.

It follows that, strictly speaking, acts of violence whose sole purpose is to eliminate a hated enemy (such as the assassination of a rival chieftain, or mass murder by an apocalyptic cult) should not, at least from this perspective, be categorized as terrorism. Neither should violence that only incidentally causes fear in a community (such as the predations of a serial rapist), so long as the perpetrator(s) of any of these acts lack the intention to influence a wider audience. At the same time, terrorism can be utilized by any type of actor and for a multiplicity of causes, whether the violence involves states or

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[38] One proposed solution, and the one largely adopted by the United Nations, is to avoid controversy by drafting international conventions that outlaw specific acts associated with terrorism without mentioning or defining the term itself, such as the 1970 *Convention for the Suppression of Unlawful Seizure of Aircraft*. While this 'functional' approach has proven somewhat useful, because it focuses *post hoc* on the assailants and not on the wider networks involved in terrorism, it does little to enable cooperation against the larger terrorist organizational structure and even less for cooperation in proactively neutralizing a particular terrorist threat.

[39] Bale and Ackerman, p.12.

non-state actors, groups or individuals, or occurs during times of war or peace.

Terrorism, as used in the present study will therefore be defined as: *The intentional use or threatened use of violence, directed against victims selected for their symbolic or representative value, as a means of instilling anxiety in, transmitting one or more messages to, and thereby manipulating the attitudes and behaviour of a wider target audience or audiences*.[40]

By extension, while a wide variety of actors can employ terrorism as part of their tactical and strategic repertoire, the label of 'terrorist' will be reserved for actors where the majority of their violent activities can be classed as terrorism. Although few would argue that the vast majority of terrorist acts thus defined have historically been committed by oppressive states against their own (or other states') citizens, this species of terrorism involves a uniquely large, well-resourced and structured perpetrator and its actions are deserving of separate consideration. Therefore, this study will deal exclusively with non-state actors and from here onwards the use of the terms 'terrorism' and 'terrorist' is to be regarded in this context. I will also use the terms 'group' and 'organization' interchangeably in the broad sense of a social structure that can be discerned from its environment (often through membership criteria), where individuals cooperate systematically in order to pursue collective goals. A terrorist group or terrorist organization is then defined as a group or organization where the majority of its actions are oriented towards terrorism.

These definitions may not be suitable for all persons or purposes and are thus offered solely with the intention of elucidating the current discussion. Bearing in mind the words of J. Bower Bell that 'no matter what tools of analysis a scholar carries into the terrorist thicket, rarely is the venture begun or ended disinterestedly',[41] I do not seek to make any broader claims in the definitional fray surrounding terrorism.

Emerging Technology and Innovation

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[40] This definition is based on that espoused by Jeffrey Bale. See Gary Ackerman, et. al., *Assessing Terrorist Motivations for Attacking Critical Infrastructure,* Report for Lawrence Livermore National Laboratory for the Department of Homeland Security (Monterey, California: Monterey Institute of International Studies, 2004), p. 15 (ftn 51). Accessed at https://e-reports-ext.llnl.gov/pdf/341566.pdf on 10 January 2010.

[41] J. Bowyer Bell, 'Trends on Terror: The Analysis of Political Violence', *World Politics* 29:3 (April 1977), p.487.

Without dipping any toes into debates between economists, say, and anthropologists on the meaning of technology, these terms, as they are to be understood in the text, will be clarified. I use 'technology' in the sense of *knowledge applied for a practical purpose in order to affect and control the user's environment*.[42] It can involve material objects, as well as systems, processes and techniques, but is always purposive. Technology is linked conceptually to both science and engineering (and usually flows from one or both of these activities), but can exist independent of either.[43] 'Weapons technology' is therefore technology specifically designed to inflict harm on other human beings or their property.

'Emerging technologies' are defined as *significant technological developments either recently manifested or on the horizon*. For this study, the application of the term will be operationalized to denote technologies that are at the very least either currently in the prototype stage or those that are widely regarded as practically feasible with a functioning prototype possible within a decade of the time of writing. The technologies at the core of the study, then, consist of both those that might facilitate the acquisition or development of weapons by terrorists, and those technologies that in themselves might constitute weapons.

Innovation generally refers to the introduction of a new technology or process and this meaning will be retained, with some addenda. First, following Joel Mokyr, a distinction will be drawn between invention and innovation. The former involves 'an increment in the set of the total technological knowledge of a given society',[44] while the latter carries the connotation of the interaction of this new knowledge with the broader environment. An invention can therefore occur in the mind of a single brilliant scientist, but does not become an innovation until it is 'released into the wild', so to speak, and becomes embedded in one or more organizational, cultural, economic and social contexts. Mokyr argues that the two concepts, at least in the long run, are complements.[45]

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[42] This is similar to that of the Merriam-Webster Dictionary: 'the practical application of knowledge especially in a particular area' (Springfield, MA: Merriam Webster, 2004).
[43] Stone Age man, for instance, crafted several tools and processes such as making fire without anything that could be described as scientific understanding or engineering prowess.
[44] Joel Mokyr, *The Lever of Riches* (New York: Oxford University Press, 1990), p.10.
[45] Ibid, p.11.

Second, this study focuses on technological innovation, rather than the purely social kind,[46] so it is not necessary to enter debates about the factors affecting the innovation of memes, legal regimes, sacred values and the like. Moreover, the analysis will converge on weapons and weapons-related technologies, which means that it can to a large extent ignore the particular complexities that arise from non-weapon tactical innovation *per se*.

Third, while some authors distinguish between innovation, adaptation and emulation, restricting innovation to truly novel ideas, since there are few, if any, examples of terrorists actually *inventing* any technology from whole cloth, there does not seem to be much value in insisting on this distinction. This study will therefore follow Dolnik[47] in including adaptation and emulation of existing technology within the rubric of innovation.

Last, innovation should always be viewed in a relative sense, i.e., innovation as such should be evaluated within a particular sphere of activity. So, for example, if a new technique is described as a terrorist innovation, this implies that it is novel only insofar as no terrorists have utilized it before, even though it may have existed for some time in industry or a state military. If a new weapon is novel only in the context of a particular terrorist organization, for example, Hizb'allah, it will be described as a Hizb'allah innovation, etc. In the context of this study, then, 'innovation' will be defined as: *the introduction of a technology or process that is novel to a specific social context, through invention, adaptation or emulation and the integration of said technology or process into the given context*.[48]

Having brought some conceptual orderliness to the proceedings through the definition of terms, it remains to more diligently mark the outer boundaries of the study. First, as the consummate asymmetric opponents of our age, terrorist organizations as defined will remain the focus of the analysis and their behaviour relative to weapons adoption will be examined closely. After all, terrorist organizations, mostly lacking their own

[46] For a discussion of social innovation, see Steven Peter Rosen, *Innovation and the Modern Military: Winning the Next War* (Ithaca, NY: Cornell University Press, 1991), p.40.
[47] Dolnik, p.5.
[48] This is similar to the definition chosen by Dolnik: 'an act of introduction of a new method or technology or the improvement of an already existing capability', (Ibid., p.6.) although I have emphasized embedding in a social context and have not included improvement of an existing capability within the definition.

territorial control, often espousing deviant ideologies and explicitly focusing on a variety of audiences, usually seek to strike targets that are located deep in their opponents' territory, while avoiding far superior counterterrorist forces. This provides a rich strategic, tactical, organizational and social context in which to explore the phenomenon of non-state weapons adoption. Furthermore, their penchant for targeting civilians means that their successful adoption of new weapons might have particularly grave consequences and thus warrants close study.

Second, the study will not single out WMD or CBRN weapons as objects of analysis. While many emerging technologies will affect the ease with which CBRN weapons can be acquired, produced or utilized, and the adoption of WMD-relevant technologies is clearly a matter of serious policy concern, given the above discussion, it is premature to focus exclusively on a narrow set of WMD-related technologies when the basic elements and processes of terrorist weapons adoption remain poorly understood. So, although CBRN weapons and related technologies will be referred to periodically during the study and will be used to illustrate some of the policy implications of the research in the concluding section, the application of the insights gained to the specific context of WMD is left for future research.

Third, while the general dynamics of technological innovation are an important part of the analysis, the focus will remain on those technologies and dynamics most likely to intersect with violent non-state actors, as opposed to emerging technologies writ large. For example, the dynamics of biotechnology diffusion will be favoured over those of the development of accounting software.

Weapons Adoption in a Dynamic Context

The history of conflict is replete with cautionary tales warning against relying on static evaluations of an adversary's motivations and capabilities.[49] Terrorism, especially, is an inherently dynamic phenomenon. Indeed, if terrorist actions over the past four decades have taught us anything, it is that among today's often amorphous, network-centric

[49] This paragraph paraphrases a portion of the author's Congressional testimony (Gary Ackerman, Testimony before United States Senate Committee on Homeland Security and Governmental Affairs, Hearing on 'Nuclear Terrorism: Assessing the Threat to the Homeland' (2 April 2008). Accessed at http://www.hsgac.senate.gov//imo/media/doc/040208Ackerman3.pdf on 2 November 2013.

groups and individuals engaging in terrorism there are audaciously nimble operators who can adapt through organizational and tactical reinvention and are prepared to persevere for long periods to attain their goals. Thus, any analytical models of terrorist weapons adoption should be able to account not only for an actor's initial motivations and capabilities, but also for how these might change over time, in response to both internal and external stimuli.

At the same time, the social, political and technological environments within which terrorists take root and function are constantly reforming into unexpected topologies, presenting both opportunities and obstacles for subversives. Perhaps the most vexing policy questions currently associated with terrorist weapons adoption relate to the impact of emerging technologies, which often possess dual-use characteristics. Since several of these questions will be addressed at the end of this study, it is appropriate at this juncture to introduce at least some of the broader concerns that emerging technologies might present for those seeking to counter the threat of terrorism. It should be emphasized, however, that weapons innovation on the part of terrorists does not necessarily involve high-technology, sophisticated apparatus.[50]

Turning, therefore, to the technological context that might tempt terrorists to innovate in the direction of new weapons, we can take as our point of departure the tremendous advances that have recently been made in almost every scientific and technical endeavour, a portion of which are germane to the production and deployment of terrorist weapons. Little argument is necessary to convince even the casual observer of the remarkable recent progress in the biotechnology, pharmaceutical, microelectronic, materials and software industries, to name just a few. Yet, lurking behind the glowing press releases detailing new drug delivery systems[51] and miracle nanofabrics that clean themselves,[52] there is often – even to those not fixated on security issues – a faint sense of foreboding about the consequences of such rapid progress.[53] Such disquiet is nothing

[50] Wilkinson, p. 6.
[51] For example, see the newsletter 'Fierce Drug Delivery' (http://www.fiercedrugdelivery.com) for many innovations in drug delivery systems.
[52] 'Cotton fabric cleans itself when exposed to ordinary sunlight', *Phys.Org News* (14 Dec 2011). Accessed at http://phys.org/news/2011-12-cotton-fabric-exposed-ordinary-sunlight.html on 10 October 2013.
[53] Alvin and Heidi Toffler have argued that the dangers posed by emerging technologies are especially acute in the current age, reflecting a Third Wave of human activity dominated by knowledge as opposed to the previous waves of agriculture and industrialization (Alvin and Heidi Toffler, *War and Anti-War* (London: Warner Books, 1993), pp. 25 and 243).

new – visionaries as far back as Roger Bacon in the thirteenth century and Leonardo da Vinci in the fifteenth recognized that scientific and technological progress has a dark side. It is noteworthy that both these men, who between them foresaw the airplane, helicopter, tank, automobile and much else besides, attempted to obfuscate and encipher those parts of their research which they believed would prove dangerous in the wrong hands.

There are a variety of ways in which budding technological advances might provide malefactors with new opportunities for inflicting harm. First, emerging technologies might remove obstacles to the acquisition of raw materials. For example, if so-called 'gene fabs' can synthesize microorganisms from scratch, why bother with trying to get one's hands on a closely-guarded sample of the smallpox virus? Or, if laser isotope separation becomes feasible on a commercial scale, perhaps terrorists will one day no longer be forced to scour the risky 'black market' to obtain fissile material for a nuclear bomb. Second, new technologies may facilitate the production and weaponization of harm agents, in terms of providing greater safety,[54] leaving less of a footprint detectable by authorities, enabling cheaper production, or lowering the required skill level of personnel involved. For example, whereas previously certain complex microbiological procedures required the use of expensive equipment and several highly-trained technicians, the recent advent of commercial biotechnology 'kits' might now enable individuals with only basic skills to successfully complete the same procedures,[55] a clear boon to those terrorists seeking biological weapons. Also, microreactors, consisting of fluid transfer platforms barely larger than a microchip, could allow for the less hazardous combination of chemical weapons precursors.[56] Third, to ensure that a new weapon, say a home-made mortar, is truly capable of causing mass casualties currently requires extensive testing and trial and error, all of which increases the chances of something going wrong and inadvertently alerting law enforcement or intelligence agencies.[57] New simulation software and the reliability afforded by modern

[54] Maurer describes the extensive history of terrorist bomb-factory explosions since the 1870s and observes that in general accidents pose an acute security weakness for terrorists. Stephen M. Maurer, *The Third Wave*, Video lecture (2005). Accessed at http:www.cs.washington.edu/education/courses/csep590/05au/lectures/slides/Maurer_Sept7.pdf on 10 January 2010.

[55] Seth Carus and Raymond Zilinskas, *Possible Terrorist Use of Modern Biotechnology Techniques* (Washington, DC: National Defense University Center for Counterproliferation Research, April 2002).

[56] Smithson, pp. 80-81.

[57] Maurer (2009), pp. 64, 77 and 79.

equipment can conceivably reduce (although probably not completely obviate) the need for testing. Last, technology might provide for entirely new types of weapons. Potential examples include metastable nuclear isomers and self-replicating nanites.

The above examples should suffice to drive home the point that there are a range of technological advances, either currently available or on the horizon, that might facilitate the acquisition or use of new weapons by malicious actors. Yet, it is not only the bare invention of new scientific theories or even their application in technologies that presents a potential threat. After all, it is quite unlikely that terrorists will be caught peeking over the shoulders of university scientists going about their research. Rather, in the context of terrorism, the dangers are likely to stem from the maturation of existing advanced technologies, as these technologies transition from basic research into commercially available 'off-the-shelf' applications. It is therefore the discovery of new products and processes combined with the widespread diffusion and commercial exploitation of the resultant technologies that is more likely to bring them closer to terrorist hands.

Over and above the advanced state of current technology, the rate of change is of concern. Technological development in general is accelerating, as new technologies enable even more rapid growth in what Ray Kurzweil, a prominent futurist who focuses on technology, refers to as the 'law of accelerating returns'.[58] Part of this phenomenon of constant change no doubt has its roots in the fact that technology both accretes and commoditizes. To understand why, one must first take note of the obvious fact that once discovered, a technology cannot be uninvented – students of strategic doctrine are all too familiar with the truism that the nuclear weapons genii cannot be put back in his bottle. Yet what is less well understood is that at least some portion of the engineers and scientists who follow the inventors of an innovative product or process – needing some outlet for their intellects and their skills – will continue to build on what has come before, making each generation of the technology faster, cheaper, or easier to produce and use. All of this does not even begin to take into account the role of discontinuous, unexpected and revolutionary changes in technology, which only serve to compound the problem.

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[58] See Ray Kurzweil, *The Singularity is Near* (New York: Penguin Books, 2005), pp. 96. See also, Ibid., pp. 7-8, 12 and 25 and Toffler and Toffler, p. 327.

Furthermore, increasing globalization means that as a technology matures, the products based thereon proliferate worldwide at an astonishing pace. For example, globalization and information technology are likely creating a more technically literate global population. In an age where almost no spot on earth remains untouched by the information revolution, disaffected youths in even the most underdeveloped countries can now take technical courses online. Conversely, virtual radicalization through the Internet means that even the best and the brightest attendees of the most esteemed institutions of research and higher learning in the developed world may become susceptible to radicalization. Such changes might thus empower the violent aspirations of individuals, small groups, and terrorist networks.

At the same time, it must be stressed that this study is not a discourse on technological advancement, *per se*, or even a complete catalogue of technological developments with relevance to terrorist weapons. Indeed, beyond this introduction, details of the emerging technologies themselves will only be discussed for illustrative purposes. Rather, this study will focus on the little-explored topic of the *relationship* of terrorists to weapons adoption in general and novel weapons opportunities in particular. In many ways, the technical characteristics of emerging technologies take second stage to the interaction between terrorists and these technologies; while the technical attributes are an important component of this interaction, they are no more important than, say, the ideological or organizational aspects. For as I will show, it is these latter factors, acting in concert with the nature of the technology itself, that are more likely to have a determining effect on which terrorists will embrace new weapons technologies and which will reject (or even remain unaware of) them, or, perhaps more importantly for policy purposes, which terrorists are likely to succeed and which to fail in their adoption efforts. In essence, '[t]echnology must be an important factor in any appreciation of the problems of terrorism and counter-terrorism in modern society', as Paul Wilkinson states, but '…it must always be placed in the wider context of social, economic and political needs and problems, at national and international levels, if its role is to be properly understood'.[59]

Thus, even if it is not possible to accurately forecast the advent and opportunities for exploitation presented by a particular emerging technology, the study aims to lend

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[59] Paul Wilkinson, pp. 3-4.

greater prescience to how different terrorist actors are likely to react to such changes (if and when they occur). It can thereby enable a better assessment of the nexus between the technology and the terrorist milieu, as well as identify opportunities for threat prevention or interdiction.

Structure

This study is an admittedly ambitious undertaking and it is necessary to proceed deliberately and to consolidate previous knowledge and understanding at each step along the way. The overall research strategy, however, is based on approaching the problem from two different perspectives. The first perspective, which can be termed 'outside in', will take as its locus the technological objects themselves and will specifically examine the mechanics of weapons innovation and diffusion in a general context. The second perspective, an 'inside out' approach, focuses on the terrorists as purposive actors, on their decision making vis-à-vis emerging technologies and tactics, as well as their intentions and capacity for integrating these technologies into their existing arsenals. As Ranstorp and Normark point out, the core of the issue is not the technical revolutions themselves, but how these are perceived by terrorists as pathways to violence.[60] The convergence of these two perspectives will then allow us to reconcile which of the aforementioned 'push' and 'pull' dynamics predominates and under what circumstances.

In this *Introduction*, the primary topic has been laid out and rationalized and the scope of the study established.

This is followed by the first major section of the study, which deals with the development of a theoretical model of terrorist weapons adoption that includes the potential impacts of emerging technologies. *Chapter 2* commences with the 'outside in' inquiry by more closely examining the intersection between technological development and the transformation of the use of weaponry over time, irrespective of the type of actors involved. Particular attention is paid to the factors that have influenced the adoption by both state and non-state actors of new weapons, including the strategic and tactical considerations that have affected, and have been affected by, technological

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[60] Magnus Ranstorp and Magnus Normark, 'Conclusion', in Ranstorp and Normark (eds.), p.199.

advances, as well as the determinants of adoption success and failure. While history is admittedly not a perfect guide, it can at least assist in identifying and navigating the structural and contingent elements of a process – in this instance weapons development and diffusion – which constrain choices or act as 'attractors' making some decisions more likely than others.

Chapter 3 explores the 'inside out' approach and shifts focus from the objects of diffusion to the prospective adopters. The chapter broadly reviews the existing literature regarding technological innovation and diffusion, where possible focusing on the terrorism studies literature. It therefore considers how terrorists approach innovation, both in general and specifically with respect to new technologies and weapons selection. The existing studies of Dolnik, Jackson et. al. and several others are used to provide a basis for understanding the factors influencing terrorist innovation and adoption of new technologies. Yet, as noted earlier, there is a need to delve deeper and to integrate both the behavioural and technological dynamics involved. To do so requires supplementing the existing understanding of terrorist weapons innovation in two ways. First, relevant insights are drawn from research into other aspects of terrorist decision-making and terrorist learning.[61] After all, the transition from awareness to selection to adoption of new weapons technologies (including knowledge transfer, materials acquisition, production and testing) is driven and shaped by a host of factors as varied as the terrorist group's ideology, mechanisms of control, degree of factionalization, demographics, the security environment, historical experience, perceptual biases and risk thresholds. Prior work in each of these areas will be consulted. Second, where the existing terrorism literature is sparse on the underlying dynamics and processes, the net is cast as widely as possible, drawing on sources from as far afield as management science, organizational psychology, economics and sociology. Those theories and propositions that have received significant empirical support and that seem to hold the most promise for application to the terrorist realm, especially to the questions posed here, are identified and briefly explained.

[61] Even this literature is quite spare. Among its main representative works are Gordon H. McCormick, 'Terrorist Decision Making', *Annual Reviews in Political Science* 6 (2003), C.J.M Drake, *Terrorists' Target Selection* (New York: St. Martin's, 1998), Kenney, and James J. F. Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006).

The insights derived from the historical survey on weapons development in Chapter 2 are then combined with the theories and findings from terrorist and general innovation and learning in Chapter 3 to develop a theoretical framework for terrorist adoption of new weapons in *Chapter 4*, one which can incorporate terrorist responses to emerging technologies.

Section 2 exposes the theoretical framework for the terrorist adoption of weapons technology developed in Section 1 to real-world experience. In the history of terrorism there have been over 2,000 different terrorist groups recorded, who between them have committed over 81,000 attacks since 1970,[62] making testing each and every one of these against every new and existing technology that has emerged in the past forty years impractical to say the least. Preliminary empirical verification is therefore accomplished through qualitative means, namely the use of a hybrid case study design combining elements of the case-control[63] and process tracing[64] methods, an approach that is outlined in *Chapter 5*. This entails performing structured process tracing on each member of a pair of similarly situated terrorist organizations to analyse their organizational and behavioural paths to adoption or non-adoption across three different weapons. Within each pair, one organization progressed considerably further along the weapons adoption pathway than the other, which provides variance in the dependent variables of the adoption process.

Chapter 6 presents the first set of paired case studies, which explore mortar technology adoption across the Provisional Irish Republican Army (PIRA) and the Irish National Liberation Army (INLA). *Chapter 7* provides a similar study of the adoption or lack thereof of both rockets and cyanide across two right-wing extremist organizations in the United States in the early 1980s, namely the Covenant, the Sword and the Arm of the Lord and The Order. The experiences of the studied organizations are comparatively analysed in *Chapter 8*, first contrasting the members of each paired case study with each other and then considering relevant features across all of the cases. The adoption paths

[62] *Global Terrorism Database* (College Park, Maryland: National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2013). Accessed at http://www.start.umd.edu/gtd.
[63] Paul Stolley and James Schlesselman. *Case-control studies: design, conduct, analysis* (Oxford: Oxford University Press, 1982).
[64] Alexander L. George and Andrew Bennett, *Case Studies and Theory Development in the Social Sciences* (Cambridge, Mass.: MIT Press, 2005).

and salient variables identified in the theoretical framework are thereafter compared against the cases to evaluate the framework's explanatory power.

Chapter 9 revisits the framing issues put forward in this chapter, in the context of the theoretical framework and empirical applications produced in the preceding chapters. In addition, certain of the major policy implications of the results are considered, particularly as these relate to emerging technologies and government responses to the terrorism threat. At its conclusion, the study largely undermines the three terrorist weapons adoption assumptions put forward earlier and challenges notions of technological determinism with respect to terrorists and emerging technologies. In so doing, it identifies several key factors that can confound or facilitate a terrorist group's successful adoption of a new weapon and develops a model that can be applied to discern between those terrorists that are likely to embrace new technologies of lethality and those that will stumble along the way.

The study is therefore original in at least three respects. First, as discussed above, it addresses a key lacuna in the existing understanding of the operational choices of terrorists and the impacts thereof. Second, in so doing, the study creates a testable construct of new weapons adoption by terrorists that can be applied in both academic and practitioner contexts. Third, the study includes original research on four historical terrorist organizations that helps explicate the differences in their levels of innovation and weapons adoption.

Overall, this study seeks to fill a gap in current research on the topic of terrorist behaviour by considering the dynamics of technological and organizational change with respect to weapons selection, with the ultimate purpose being to inform policy decisions and to assist in developing efficient preparations against what is regarded as one of the prime security issues of the 21st century. To accomplish this task, the study chapters consecutively construct an analytic framework which consists of marrying existing models of weapons innovation and technology adoption to the particular domain of terrorism and then evaluating this in an empirical context.

Chapter 2: The Diffusion of Weapons – A Theoretical and Historical Analysis

The path across the analytical terrain that has been laid out begins with an examination of the broad class of objects whose adoption I seek to elucidate, that is, the physical instruments of conflict themselves. It is here that I concern myself with the particularities surrounding the diffusion and adoption of weaponry. This chapter investigates the theoretical basis for weapons adoption and queries the historical record for insights regarding the dynamics of weapons adoption and diffusion among both state and non-state actors. These insights, where applicable, will in turn be used to guide the development in subsequent chapters, of a theoretical model of how terrorists might respond to changes in weapons-relevant technologies.

We are on fertile experiential ground when examining how and why actors adopt novel means of combat, so this portion of the analysis lends itself more easily to the historical approach. Yet, we must still be cautious lest we place too great a demand on the general history of weapons diffusion in explaining terrorist decisions regarding adopting new weapons. Therefore, while this chapter will draw on the historical record in search of insights that might inform our understanding of the behaviour of actors confronted with novel weapons and combat technologies, it recognizes that terrorists differ in many respects from other species of combatant and attempts to identify those aspects of weapons diffusion which are likelier to permeate the boundaries between contemporary terrorism and other forms of conflict.

Conflict and technology are ineluctably intertwined and have been since the earliest days when primitive combatants began using simple tools to extend the destructive power of the bare hand, foot or tooth. In more modern times, no aspect of combat – from the machinery of destruction to the gathering of intelligence and command – is, in the words of Martin van Creveld, 'immune to the impact that technology has had and does have and always will have'.[1] Expectedly then, the history of weapons development and the advent of military technology represent ground that has been well-trodden by

[1] Martin Van Creveld, *Technology and War: From 2000 B.C. to the Present* (New York: The Free Press, 1991), p.1.

military historians and historians of technology alike,[2] making a comprehensive exegesis of the wider subject unnecessary and even a little presumptuous. Yet, although prior scholarship will provide the bedrock for the discussion that follows, this investigation must go beyond a straightforward synthesis of the literature and look down upon history from a somewhat atypical vantage point, one established by the overall objective of understanding the *terrorist* adoption of weapons and associated technologies. The analysis must, by extension, therefore emphasize certain facets of weapons development and adoption over others.

First, without descending into the vociferous debates surrounding what constitutes a 'military technical revolution' and whether the world's militaries are currently engaged in one, I build on the general innovation discussion in the first chapter. In this regard, I argue that it makes most sense to view a weapons innovation as a perceptible (and perceived) departure from continuity in existing means of exerting force and also that the term innovation implies more than bare invention, but rather the manifesting of the new weapon into a social, political and economic reality. Weapons innovation is thus weapons invention plus process and context.

Second, with respect to this developmental continuum, the inquiry will focus less on the invention stages of new weapons development than on the determinants and consequences surrounding their adoption and spread. Since terrorists are unlikely to themselves engage in scientific derivations of completely new weapons from first principles, the admittedly quite fascinating stories of the initial discovery of, say, the chemistry of gunpowder are of less concern here. Rather, the emphasis will lie on the manner in which other actors besides the original inventor of a weapon became aware of

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[2] For general surveys, see, *inter alia*, Max Boot, *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York, NY: Gothman Books, 2006); Van Creveld; Geoffrey Parker, *The Military Revolution* (New York: Cambridge University Press, 2007); Bert S. Hall, *Weapons and Warfare in Renaissance Europe* (Baltimore, MD: The Johns Hopkins University Press, 1997); Trevor N. Dupuy, *The Evolution of Weapons and Warfare* (Cambridge, MA: Da Capo Press, 1990); Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005); Ernest Volkman, *Science Goes to War: The Search for the Ultimate Weapon, From Greek Fire to Star Wars* (New York, NY: John Wiley & Sons, 2002); Bernard Brodie and Fawn M. Brodie, *From Crossbow to H-Bomb* (Bloomington, IN: Indiana University Press, 1973); and J.A. Lynn (ed.), *Tools of War: Instruments, Ideas, and Institutions of Warfare, 1445-1871* (Urbana: University of Illinois Press, 1990). However, as Eliason and Goldman assert, 'despite the large body of scholarship on military innovation, remarkably few studies explore either historical or contemporary processes of diffusion of military innovation', Leslie Eliason and Emily Goldman, 'Introduction: Theoretical and Comparative Perspectives on Innovation and Diffusion', in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), p.7.

it, how they made their decisions whether or not to adopt the weapon and how the new article was embraced and fielded. Of course, weapons development does not occur in clean discrete phases along a predetermined pathway, but can, for example, proceed through several cycles of improvement and refinement (as was the case with field artillery) or be partially developed by one set of actors and then perfected by a completely different set of actors, sometimes after a substantial delay (battlefield rockets). The various activities that occur after the initial development and diffusion of a weapon must therefore be included in the discussion, including improvement, improvisation and tactical or strategic innovation in the way the weapon is used.

Third, while the nature of a weapon's effects will play a large part in prioritizing selections from the historical record, details of these effects themselves, a topic upon which a large portion of the historiography converges, are relegated to a supporting role, with the factors affecting adoption taking centre stage. Weapons performance is still mentioned, but only insofar as this influences adoption and diffusion behaviours.

Turning to the analysis itself, this draws upon a broad yet concise exposition of the historical development of weapons, which can be found in Appendix A. The primary rationale for casting a broad net rather than simply selecting a handful of recent or putatively representative cases, lies in the nature of the actors about whose behaviour the survey is intended to inform. Modern terrorists, as non-state actors operating in a globalized world, encompass a wide range of technical capabilities. It might very well turn out, therefore, that the adoption experience of early fourteenth century European armies when presented with the supremely efficacious battlefield use of the longbow is more akin to that faced by several of today's terrorist organizations than the highly bureaucratized and politicized military research and development structures that have dominated Western military procurement since the latter half of the twentieth century. Moreover, since the terrorists of today and tomorrow hail from a multiplicity of ethnic, religious and cultural backgrounds, a focus on any particular region or cultural milieu would seem to be inherently limiting. That being said, there is far more available information for some areas and time periods; the most that can be attempted is to balance broadness of scope with availability of sources.

Setting aside wider epistemological concerns, there remain several practical obstacles to drawing defensible inferences from the historical record. The first is the lack of sufficient information in the existing historical record of the early development and spread of many weapons, especially those of a more ancient nature. For example, details on the circumstances surrounding the early diffusion of the crossbow remain obscure. Such basic lacunae in the historical record of military technology development are compounded by what Jeremy Black refers to as 'the questionable nature of the relationship between literature and practice'[3] when it comes to the ways wars are fought – whether through conscious selectivity on the part of those reporting events or simply because contemporary chroniclers could not have known (or perhaps even cared) which aspects of reality would be of interest to future scholars.

The converse problem also on occasion presents itself; in certain cases, especially those of the recent past, adoption behaviour seems to be overdetermined, with substantial quantities of available data at least partially supporting a variety of hypotheses and seemingly little at hand to refute any of them.[4] A pertinent example is the adoption of the aircraft carrier, which may have been prompted by realization of the inherent advantages of air power, the limitations imposed on battleships by the Washington Treaty, concerns of status, or some combination of all three.

The above problems are well-known to any serious student of history and historians toil much of their professional lives to ameliorate them. Therefore, in addition to the obvious exigencies of limitations on space and effort, this chapter will rely primarily on secondary sources published by eminent military historians. Of course, such an approach increases the responsibility to critically evaluate as many sources as possible and to pay special attention to points of the greatest concurrence among scholars. In sum, while the following survey might stake out a somewhat unique vantage point, it will nonetheless be one that is situated on the shoulders of giants.

One last note of caution before proceeding with the substance of the survey: we must remain cognizant that perennially present in any endeavour such as this is the danger of hindsight bias – that instead of learning from the past, we project our own mental

[3] Jeremy Black, 'Determinisms and Other Issues', *Journal of Military History*, 68:4 (2004), p. 1229.
[4] For a discussion of overdetermination in the general context of technological change, see Mokyr (1990), pp. 6-8.

constructions of the present onto the historical record and thus interpret past events according to our existing sociological frame of reference. We must thus be mindful that the ubiquity and rapid pace of technological change in the present does not cause us to exaggerate its impact in previous ages, particularly as it relates to weapons development and diffusion.

The historical survey that has been undertaken (and is presented in Appendix A) is necessarily unable to expose each and every instance of weapons adoption to a rigidly systematic analysis. Nonetheless, the author recognizes that an overly simplistic reading of the historical record can be more dangerous than none at all and that ' "technology" is a category of explanations rather than just one'.[5] Therefore, this chapter will lay claim to a middle ground of detail sufficient to the task at hand and attempt to ask the following questions of the historical record, grouped under the stages of adoption introduced in the first chapter:

1. Awareness of Innovation Possibilities:
   - *What constitutes a 'new' technology in terms of weaponry and how is innovation in this context characterized?*
   - *How do actors (both state and non-state) become aware of new weapons or of technological innovations and their attendant potential for new weapons?*

2. Factors Influencing Adoption Decisions:
   - *Who makes the decision to adopt or not to adopt the weapon or technical innovation with weapons potential? What is the organizational decision-making context (for example, deliberation or dissension amongst multiple parties or the whim of a single authoritarian decision-maker)?*
   - *What considerations are taken into account in deciding whether or not to adopt and, if the decision to adopt is made, how to manage the process?*

3. Factors Influencing Adoption Outcomes:
   - *What are the determinants of successful adoption?*
   - *How long does the process take and what obstacles are commonly encountered?*

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[5] Black, p. 1219.

Before embarking on an analysis of weapons diffusion, it is necessary to establish a theoretical context by seeking to identify models of weapons development and diffusion. To do this, the chapter is structured to first consult a variety of military theorists, both classical and modern. Thereafter, consecutive sections engage the historical record with respect to each of the above categories and questions. This is followed by an assessment of the identified theories in light of the historical record, with the final section in the chapter discussing the applicability of these findings to the terrorist domain.

Theories of Weapons Innovation and Diffusion

One cannot neglect the enormous contribution to military thought made by classical military commentators. Among well-known military strategists – from Kautilya and Musashi through Clausewitz to Fuller and Kahn – we see over time an increasing awareness and acceptance of the impact of technological developments on war, especially as these manifest in weaponry. From an almost total disregard for the role of weapons, to a grudging acknowledgement but simultaneous downplaying of their significance in favour of military spirit and stewardship, by the mid-twentieth century weapons and technology were imbued by at least some strategists with an almost reverent power to shape battle. This perhaps in part reflects the broader transition to a more technologically developed, diverse and literate global society, but the devastating and accelerating growth in firepower and mobility on the battlefield no doubt played a major part in concentrating military minds on the role of technology in war. Yet, in all the tomes of strategy, the processes of weapons development, adoption and diffusion are given scant, if any, regard. Weapons, even the most consequential among them, seem to be cast by the vast majority of military strategists up to the middle of the twentieth century as a type of *deus ex machina* which swoops down to the military sphere from on high to demand changes in strategy and doctrine. We therefore relegate detailed discussion of the place of weapons in classical commentary to Appendix A, which traces the abovementioned evolution in the understanding of the role of weapons technology in war.

It was only in the latter decades of the twentieth century, that scholars, chiefly historians, began to pay closer attention to whence the weapons came. Of course, strategists and historians are by no means distinct species – who indeed would accuse a Mahan or a Liddell Hart of an ignorance of history? – and the shift represented more one of emphasis from describing how wars *should* be fought to analysing how they *have* been fought. Nonetheless, it was not until fairly recently in the annals of conflict scholarship (really only the past four decades or so) that sustained and wide-ranging study of the origin and diffusion of innovations in weaponry has blossomed. This has enabled scholars to propose a variety of theories describing innovations in military technology, and it is to a brief overview of these theories that I now turn.

There is one prominent topic within the theoretical discourse in this area that might at first glance seem a vital element of the discussion, even though it really does not deal directly with the dynamics of weapons innovation and adoption. Nonetheless, because its persistent presence lurks like a fog over the entire subject of weapons and warfare, it warrants at least a brief mention. I am speaking of the debate over social technological determinism, the notion that technological developments (including their manifestation in weaponry) are the prime movers of changes in society, including determining the shape of any major military engagements or outcomes. Several prominent scholars have expended great effort in debating the extent to which technology determines both the onset and outcome of war and providing what they see as a necessary corrective to an apparent post-World War II military fascination with novel technologies.[6] For current purposes, this debate is something of a red herring in that this study is concerned with the extent to which a handful of weapons technologies drive terrorist behaviour, rather than the far loftier questions of whether technology drives history, which are at the core of several theoretical debates. So, whereas an approach like the Toffler 'three wave' theory can be argued to be deterministic, in the sense that it a) describes the latest wave of human society as characterized by the dominance of information and knowledge which permeate modern warfare, and b) predicts conflict between third-wave societies and their less developed second- and first-wave counterparts,[7] this is more helpful in explaining what the world looks like and how it happened to be that way (including the myriad high-tech military innovations they describe), than it is in guiding us as to which

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[6] For a small sample of this discourse, see Black; and M. R. Smith and L. Marx (eds.), *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, MA, 1994). Many existing surveys (Boot, p.9; Van Creveld, pp.5-6; Colin Gray, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History* (London: Frank Cass, 2002), pp. 36-39) take pains to play down any hint of determinism, while still arguing that technology (and weapons) play a large role in warfare.
[7] See chapter 1, footnote 50.

particular actors might choose to embrace these technologies and their success in doing so. The same goes for much of the remainder of the debate, which thus becomes useful primarily as a check on the present analysis lapsing into quasi-deterministic language. On the other hand, this is not to say that in specific circumstances, technological advances cannot have a profound (or even decisive) effect on the choices of actors as these relate to weapons, but merely to caution against simplistic assumptions that 'technology' as a construct necessarily exerts a uniform and overriding force in the decision making of all those who encounter it.

Causal Theories

Those theoretical models of most interest to us here are the ones that attempt to explain different aspects of the innovation and diffusion process, especially those that bear on the decision of whether an innovation is adopted or not. One type of theoretical discussion examines the causes – actors, motivations and decisions – involved in the adoption (and hence diffusion) of military innovations, and another set of theories looks at the ultimate effects of deciding to adopt or not to adopt the innovation.[8] While several of these theories are broadly configured for various sorts of military innovations (including those dealing with personnel and doctrine), for current purposes they will be outlined only as they apply to the specific context of weapons development, spread and adoption.

Theories of the causes and motivations behind weapons adoption and diffusion in essence boil down to the familiar International Relations disputation over the correct level of analysis to emphasize. Focusing on the level of the international system, the neorealist viewpoint sees weapons development in rather simple terms, as a product of strategic necessity. According to this strain of thought, which is best epitomized by the work of Kenneth Waltz, unceasing competition in the international system provides a strong incentive for states to emulate any advantageous developments in weaponry for fear that not doing so will place them at a dangerous disadvantage relative to those states that do.[9] This momentum to adopt innovations is believed by proponents to

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[8] The schema used here is inspired by, but differs from, that laid out in Eliason and Goldman, pp. 10-11.
[9] Kenneth N. Waltz, *Theory of International Politics* (New York: McGraw-Hill, 1979), p. 127; Joao Resende-Santos, 'Anarchy and Emulation of Military Systems: Military Organizations and Technology in South America, 1870-1930', *Security Studies* 5:3 (Spring 1996), p. 196.

override any cultural or other contextual differences between states,[10] with resource and skill levels being the only constraints on adoption.[11] Hall describes this idea in Darwinian terms, in which a weapons innovation by one state is compared to a mutation in an organism, and the other states must either adapt (i.e. adopt a similar or complementary mechanism) or perish,[12] a process that is carried out by military organs and becomes especially concentrated during times of conflict.[13]

The first implication of this theory is that the diffusion of weapons will be rapid and that innovations will quickly become ubiquitous, leading all states (or at least those intending to survive and thrive) to pursue essentially the same armaments. As Waltz himself contends, 'The possibility that conflict will be conducted by force leads to competition in the arts and instruments of force. Competition produces a tendency toward the sameness of the competitors.'[14] The second theoretical implication is the development of arms races, as each state tries to catch up to the innovations of its competitors, which in turn spurs secondary innovations that begin the cycle anew. This is encapsulated in the oft-stated 'offence-defence' dynamic with respect to weaponry, which is believed by some to be so central that it is painted as the key impetus in weapons development.[15] Hugh Turney-High thus goes so far as to claim that '[t]he offense thinks up new weapons or improves the old ones so that the defence's genius must think up new defence or be crushed out of existence. There is nothing new nor old in this. The entire history and prehistory of weapons is summarized in this cycle'.[16] A final implication of this neorealist approach to military innovation is that the diffusion process is assumed to begin with the most powerful and advanced states in the system and flow down to the subordinate states, with some versions of the theory describing the specific mechanisms through which this can occur, including forced penetration,[17]

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[10] See the discussion in Eliason and Goldman, pp. 15, 16, and 21.
[11] James F. Dunnigan, *Digital Soldiers: The Evolution of High-Tech Weaponry and Tomorrow's Brave New Battlefield* (New York: St. Martin's Griffin, 1998), p. xv.
[12] Hall, p. 3.
[13] Rosen, pp. 21-22.
[14] Waltz, p. 128 cited in Eliason and Goldman, p. 8.
[15] Clifford J. Rogers ('The Military Revolutions of the Hundred Years' War' in Clifford J. Rogers (ed.), *The Military Revolutions Debate* (Westview Press, 1995), pp. 55-93) proposes a similar version of this dynamic at a longer timescale in which a military innovation causes a temporary disequilibrium in the system of warfare, which prompts a search for new military means to restore equilibrium. Colin Gray (p.48) critiques this notion as overly orderly and deterministic in light of historical evidence.
[16] Harry H. Turney-High, *Primitive War: Its practice and concepts* (Columbia, SC: University of South Carolina Press, 1949), p. 7.
[17] See Eliason and Goldman, p. 17 who cite Colin J. Bennett, 'Review Article: What is Policy Convergence and What Causes It?', *British Journal of Political Science,* 21:2 (1991), p. 225.

alliance obligations, bandwagoning[18] and competition from a local rival.

An immediate potential weakness for this theory is that it depends on perfect information – it assumes that states will have sufficient and sufficiently reliable intelligence about innovations occurring within other states in the system so as to first recognize when a significant weapons innovation has occurred and then to copy or adapt that innovation (or develop a counterinnovation) before the adopting state can be prejudiced by the innovation in any contest of force.

The bulk of the opposition to this approach, however, arises from the fact that – like much neorealist thought – it disregards or discounts to the point of insignificance a variety of factors operating at the sub-state level. These include such considerations as cultural attitudes, institutional inertia and bureaucratic politics. Rival theories of military diffusion bring these intra-state dynamics to the fore. One version asserts that prevailing social or cultural attitudes towards innovation, whether among a state's political or military elite, can create a fertile or hostile environment for adopting military innovations.[19] Other variants of these theories consider national cultures in a relative sense, arguing, for example, that cultural, ideological or other affinities between the military or political leadership in the innovating and potential adopter states, respectively, tend to facilitate diffusion of military innovations.[20] Conversely, cultural or ideological divergence is asserted to often hamper the emulation and adoption of foreign weaponry. These ideas relate to the compatibility criterion in the general diffusion literature (see Chapter 3) and are partially based on the finding from general organizational theory that extended social interaction can lead to emulation irrespective of the relative objective benefits or costs in terms of efficiency or effectiveness.[21] Goldman mentions one important implication of these theoretical approaches, which is that, despite the best of intentions, any differences in compatibility (whether arising from discrepancies in military practices, values, experiences or infrastructure) will result in divergences from the original model by the adopting military institutions.[22]

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[18] For an application to the diffusion of military technology, see Chris C. Demchak, 'Creating the Enemy: Global Diffusion of the Information-Technology Based Military Model', in Goldman and Eliason (eds.), pp. 317-323.
[19] Black, p. 1223.
[20] Eliason and Goldman, pp. 15-16.
[21] Emily O. Goldman, 'Receptivity to Revolution: Carrier Air Power in Peace and War', in Goldman and Eliason (eds), p. 269; Demchak, p. 333.
[22] Goldman, 'Receptivity to Revolution', pp. 271-272.

Another theoretical perspective cast from the same sub-state mould highlights inter- and intra-organizational rivalries within adopting states. Competition over resources, favour, or influence between different bureaucratic entities within the state could lead to a particular military innovation being embraced (or rejected) merely because it is believed to strengthen the hand of one or other service or agency.

The last major theoretical approach to the motives and causes behind adoption decisions also has a sub-state focus. It postulates a natural state of institutional inertia among large organizations[23] and asserts that military organizations in particular are especially resistant to change, which presumably would include the adoption of new weapons from an external source. Like any large bureaucracy, especially hierarchical ones, state militaries are alleged to be conservative, risk averse and less than partial to any novelty that might reduce their autonomy or influence, resulting in change occurring incrementally, if at all.[24] Moreover, many regard the military as possessing a rather singular set of jealously guarded values, what John Keegan has termed a 'warrior culture' that is set 'a world apart, a very ancient world, which exists in parallel with the everyday world but does not belong to it'.[25] In the military world, obedience and reliability are by necessity paramount, and this is believed to create a distance from the rest of society that makes militaries even more resistant to new developments (especially if these hail from non-military sources) than other bureaucracies.[26] In addition, since their lives are both literally and figuratively on the line, it is argued that military men strive to minimize risks as opposed to maximizing the potential for success,[27] which can be construed as a form of behaviour described by Prospect Theory.[28] All of this means that even civilian directives to embrace a new technology might, on occasion, be unenforceable. In short, several theorists predict that the institutional inflexibility of military organizations does not tend to favour innovation.

Outcome Theories

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[23] Rosen, p. 5.
[24] Goldman, 'Receptivity to Revolution', pp. 268-269; Hall, pp. 4-5.
[25] John Keegan, *A History of Warfare* (New York: Vintage Books, 1993), p. xvi.
[26] This idea is echoed by Rosen (p. 19) and Van Creveld (p. 220).
[27] Dunnigan, p.6.
[28] For the original articulation of Prospect Theory, see Daniel Kahneman and Amos Tversky, 'Prospect Theory: An Analysis of Decision under Risk', *Econometrica*, XLVII (1979), pp. 263-291.

The second type of theory of interest to us here traces the outcome for the potential adopter of an adoption attempt and spans the implementation aspects of the decision. Although we shall see that the general diffusion of innovations literature has explored this issue deeply, and there are a host of case studies of the adoption of specific weapons,[29] there are few well-developed theoretical applications specific to the military context. Thus, for example, Goldman and Ross describe a theory of contingent capacity for adoption, wherein a military's capacity to incorporate an innovation into its existing doctrine and structure is contingent on a variety of factors, including compatibility, existing resources, bureaucratic rivalries, and other organizational traits.[30] While there is nothing inherently objectionable in these and similar approaches, the details of how these different factors fit together and interact are rarely delineated further, other than to offer that the factors take on different values across cases.

Although I have been unable to find what I regard as a systematic and comprehensive theory of the implementation of the adoption of novel weapons, there are partial exceptions in the form of theories limited to a particular set of circumstances. Rosen, for one, offers an interesting extension to the abovementioned theory of military bureaucratic decision-making, which explores the prospects for adopting innovation during wartime under different structural conditions. He argues that while a looser organizational structure may generally be more open to new ideas, a strict hierarchy and tight control mean that any new ideas that do end up being accepted are more likely to be implemented quickly. For this reason, Rosen favours a tighter organization as more amenable to innovation during wartime, although he does concede that a decentralized structure might facilitate innovation if the individual operating units were able to assemble all the needed data on their own and the innovation could be implemented without making changes to other parts of their organization.[31]

Each of the above theories addresses part of the question of how and why new weapons are adopted, but none of them provide a 'coherent model'[32] that describes the overall

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[29] These include, inter alia, those commissioned or conducted by (Williamson R. Murray and Allan R. Millett (eds.), *Military Innovation in the Interwar Period* (Cambridge: Cambridge University Press, 1998)); Hall; Lynn; Steele and Dorland (eds.); and Goldman and Eliason (eds.).
[30] Emily Goldman and Andrew Ross, 'Conclusion: The Diffusion of Military Technology and Ideas—Theory and Practice', in Goldman and Eliason (eds.), pp. 301-302.
[31] Rosen, p. 39.
[32] Hall, p.3.

weapons diffusion process, one that could form the basis for understanding terrorist adoption of weapons and weapon technologies. The analysis laid out below will therefore not only seek to determine which of the above theories are most consistently supported by the historical record, but also to identify additional factors and dynamics which pertain to the framing questions presented at the beginning of the chapter and which can then be used to supplement or enhance existing theories.

One related theoretical debate is worth noting, as it speaks to the transmission of weapons innovation. On a broad scale, it is not difficult to imagine that technological prowess and military power are correlated,[33] but the direction of causality is a matter of some debate, a debate that reduces to a disagreement over the respective roles of civilians (particularly scientists and inventors) and military institutions in driving innovation. On one side of the aisle are scholars who dust off Heraclitus to proclaim that 'War is the father of all things'.[34] They propose that war, specifically the search for new weapons, has driven advances in science and technology[35] and even go so far as to argue that the conduct of war plays a major role in shaping the political, economic, and social environment.[36] The other side downplays any possible contributions made by weapons to civilian technology and production and contends that innovative technology mostly flows the other way, from the civilian to the military world, where it is moulded into instruments of war.[37] There seems to be a tacit belief among many commentators that militaries are not naturally creative and that much of the truly consequential innovation actually occurs outside of military structures, and even outside of government altogether.[38] Other scholars echo these sentiments but take a less heroic view of the civilian sector. In this conception, those industrial or commercial interests in the civilian sector who stand to profit from disseminating a new weapons system (most notoriously, defence contractors) act to 'push' ostensible weapons innovations onto the

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[33] Mokyr (1990), p. 183 traces this idea back to Werner Sombart's *Krieg und Kapitalismus* (Munich: Duncker & Humblot, 1913).
[34] Quote listed under DK22B53 in Hermann Diels and Walther Kranz, *Die Fragmente der Vorsokratiker* (Zurich: Weidmann, 1985).
[35] Volkman, *passim*.
[36] Van Creveld, as understood by Metz (Steven Metz, 'A Wake for Clausewitz: Toward a Philosophy of 21st-Century Warfare', *Parameters*, 24 (Winter 1994-95), pp. 126-132). Turney-High (p. 253) even suggested that one reason for the emergence of the state was when its future citizens evolved beyond primitive forms of warfare, when a population witnessed 'the rise of the army with officers' (p. 253 and see also Keegan, p. 91). Such arguments sometimes tend towards the type of technological determinism mentioned earlier.
[37] Mokyr (1990), pp. 184-186
[38] Boot, p. 457.

military sector through a variety of mechanisms, not all of them entirely above board.[39]

As with any observed correlation, the truth may not lie with any of these causal arguments, or perhaps with both.[40] Since both technology and war are in many respects social constructs,[41] it is perfectly plausible that they can have reciprocal effects on one another, or are both driven by the same extraneous variable or variables percolating through the larger societal bedrock. In other words, there is no theoretical reason to dogmatically align with either of the above arguments – civilian science and technology can emigrate to the military sphere, just as instruments developed specifically to be used in combat can inspire useful spin-offs in the civilian world. Which of these alternatives is more common becomes an empirical question.

Bearing in mind the caveats to drawing inferences from a broad consideration of the historical record, I can return to the research questions posed earlier in this chapter and examine the extent to which the historical record can elucidate the process of weapons innovation and diffusion. At the same time, reference will be made to how the various theories introduced above fare in light of the historical record.

Awareness of Innovation Possibilities

Characterization of Weapons Innovation

Understanding more about the objects of adoption is a prerequisite to understanding why and how they are adopted. In this regard, the historical record provides some guidance in a number of areas related to the nature of weapons innovation itself. To begin with, the history of weapons development largely confirms general theoretical characterizations of innovation as invention plus context and process. Da Vinci, with his meticulous drawings of helicopters and tanks, was thus the archetypical weapons inventor, but was too far ahead of the materials and technical skills of his time to be a weapons innovator. A new idea for a weapon and even the diffusion of this idea therefore does not qualify as a true innovation until the idea enters a social, political

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[39] Goldman and Ross, p. 374. Dunnigan, p. xv.
[40] Barry Buzan, *An Introduction to Strategic Studies: Military Technology and International Relations* (New York: St. Martin's Press, 1987), p. 105; Mokyr (1990), p. 186.
[41] Black, p. 1223.

and, in the case of weapons, invariably physical reality. This transition from invention to innovation is usually marked by moving beyond the prototype stage to the point where the weapon is adopted by someone and first put into practice, even if on an extremely limited scale. This is useful to remember when one considers the significance of the plethora of bomb-making and poisoning materials and manuals that circumnavigate the virtual world of the Internet.

What about the 'newness' criterion? Here the answers are less clear-cut. We have defined weapons innovations as substantial or discontinuous changes in weaponry, but, as we have discussed in the introductory chapter, 'innovation' lies on a continuum and whether or not a particular development qualifies is often subjective. The question then becomes: how novel or different from extant weapons systems did weapons have to be in order for them to be regarded as innovations? This is complicated by two issues: first, that the terminology (and study) of innovation as we are using it is of fairly recent vintage, with the consequence that historical annals do not systematically distinguish in their recounting between truly innovative and merely incremental improvements and, second, that the survey in Appendix A has selected to some degree for consequential weapons, thus potentially introducing an element of circularity to any attempt to establish criteria for innovativeness.[42] Thus, much of the nature of weapons innovation must by necessity hang on our definitions thereof. This being said, a basic reading of the historical record yields few if any cases where the importance of a weapons development was not recognized contemporaneously with its appearance, but is revealed only decades or centuries later with historian's hindsight. From the development of the war-chariot to the advent of radar, military actors, once they became aware of a new weapons system, have tended to recognize when it is something significantly or qualitatively different from what has gone before. Even in a case like the Chinese stagnation in artillery development by the sixteenth century, when they eventually learned of the advances made in the West, they recognized that subsequent innovations had occurred.[43] Of course, whether or not the actors chose to act on this recognition is another matter entirely and a major element of this investigation.

Yet, with respect to the nature of the weapon itself, it is readily apparent that in the

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[42] This would logically occur when, as seems to be fairly typical, discontinuous changes in weaponry are also consequential ones.
[43] Parker, p. 137.

military sphere, innovation does not always arrive in the shape of a sudden ferocious blast felt across the battlefield, but can also take more subtle and variegated forms. Although most weapons innovations are characterized by the introduction of a novel physical apparatus, this does not necessarily have to embody substantial improvements in destructive capabilities like range, mobility or firepower. Innovations in weaponry can also arise in aspects less directly related to actual combat performance, such as costs of production or the expertise required to use the weapon. In fact, on occasion a new weapon can underperform on several physical dimensions, but still constitute an innovation, as seen with the advent of the crossbow, which was heavier, more expensive and had a lower rate of fire than either the composite bow or the longbow. The crossbow's chief source of innovation, however, derived from the dramatically shorter training period required, when compared with other bows, before a soldier became proficient with the weapon – an important advantage when expert archers took decades to develop their skills and were thus a comparatively scarce and expensive element of a military arsenal.[44]

Moreover, an innovation need not be composed of a single 'macroinvention',[45] but can arise from multiple small enhancements, which in isolation may not seem very worthy of note, but, acting together, eventually enable the weapon to cross a performance threshold and constitute an innovation. However, to qualify as a genuine innovation, the cumulative improvements much reach some sort of tipping point that creates a qualitative improvement in performance over the status quo weapons. A pertinent example is in the area of small arms, which experienced incremental advances over an extended period of several centuries, including rifled barrels, breech-loading and the percussion cap, none of which produced any military sea-change. However, when these factors came together for the first time as a mass-produced weapon in the form of Von Dreyse's Prussian needle-gun (*Zündnadelgewehr*),[46] the weapon – when combined with appropriate tactics and organization in the 1866 war with Austria – was able to revolutionize land warfare. It is, in addition, actually not uncommon in the annals of weapons innovation for a weapon to go through multiple iterations of development and

[44] See Appendix A, pp. 268-269; William H. McNeill, *The Pursuit of Power: Technology, Armed Force and Society since A.D.1000* (Chicago: University of Chicago Press, 1984), pp. 67-68, p. 80 and Hall, p. 17.
[45] Mokyr (1990), p. 13.
[46] Geoffrey L. Herrera and Thomas G. Mahnken, 'Military Diffusion in Nineteenth Century Europe: The Napoleonic and Prussian Military Systems' in Goldman and Eliason (eds.), p. 220; Boot, pp.128-129.

refinement before proving effective in combat or to be initiated by one set of actors and then consummated after significant delay by a completely different set. Perhaps one of the clearest examples is the use of self-propelled rockets on the battlefield, which from their earliest appearances in Ancient China to the Mysore Wars and the War of 1812 had played no more than a supporting and sporadic role on the battlefield, that is before making a reprise in World War II and coming to dominate modern warfare.[47]

The historical record also provides a useful corrective to the tendency to envisage weapons innovation as naturally progressing to larger and more complex forms. While this is indeed the typical direction (as seen in the case of siege engines, warships, and aircraft), in certain instances weapons have for one reason or another grown too large or complex and the innovation lies in making the weapon smaller and simpler. To mention just two examples – Charles VIII's bronze cannon that in 1494 obliterated the fortresses of the Italian kingdoms were smaller and lighter than the hulking, multi-piece bombards that preceded them[48] and Shaka Zulu's short stabbing spear provided a range of advantages over the long *assegai* in close-quarters tribal combat in 19th century southern Africa. The past century has, however, witnessed the historically curious trend of simultaneous miniaturization of weapon components and an exponential increase in their complexity.

It has been emphasized earlier that innovations do not occur in a social vacuum, and it is a truism that the level of scientific or technical knowledge must be sufficiently developed to allow for any particular invention to occur, but weapons innovations in certain cases cannot even come into existence in the absence of broader economic and social changes. The so-called 'American system' of manufacturing using interchangeable parts, which enabled the production of high-quality, mass-produced firearms,[49] is a case of the former, while the Meiji Restoration allowing for the Japanese naval modernization of the late nineteenth century is an example of the latter.[50]

The historical record also provides ample evidence for the assertion that the rates of

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47 Willey Ley, *Rockets, Missiles, and Men in Space* (New York: Viking Press, 1968), pp. 61-75 and Wernher von Braun and Frederick I. Ordway III, *Rocketry and Space Travel*, 3rd ed. (New York: Crowell, 1975), pp. 30-34.
48 Boot, p. 4.
49 McNeill, p. 331.
50 J. Charles Schencking, *Politics, Propaganda, and the Emergence of the Imperial Japanese Navy, 1868-1922* (Stanford: Stanford University Press, 2005), pp. 2-3.

technological change in general, and weapons innovation and diffusion in particular, are accelerating, especially in the wake of the Industrial Revolution. From taking centuries for new weapons to appear and sometimes even longer for them to diffuse widely, the past eight hundred years or so have seen the pace of innovation and diffusion quicken incessantly, occasionally even outstripping the ability of military organizations to understand or accommodate them. The rapid advances in naval gunnery in the late nineteenth century[51] and in guided munitions in the twentieth are but two examples.[52]

Mechanisms of Awareness

The historical survey provides some indication of how combatants become aware of innovations in weaponry. The most salient insight is that there is no single or even predominant mechanism – a variety of avenues have historically led to awareness of new weapons or innovative weapons technologies, with some of these avenues appearing more obvious than others.

First, awareness of an innovation might arise organically, through trial and error with existing implements that could serve multiple purposes, such as when pre-modern peoples realized that traditional hunting tools could be used for more than bringing down large prey, or at least for dispatching a more zoologically familial sort of prey.[53] Second, awareness of an innovation can arise from a self-reflective recognition of a specific military need or to solve a problem or set of shortcomings presented by existing weapons. This can then drive actors to either search out solutions external to the current armed forces or, where there are none, to set about the process of weapons innovation themselves.

Third, awareness of a weapons innovation can arise from its demonstration, either from being on the receiving end of its enhanced performance characteristics (presuming one survives) or preferably, witnessing or otherwise learning of instances where the new weapon or weapons system gave one side in a conflict a distinct advantage. One can

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[51] See McNeill, p. 241; Boot, p. 175; John Brooks, *Dreadnought Gunnery and the Battle of Jutland* (New York: Routledge, 2005), *passim*.
[52] See Van Creveld, p. 221; Toffler and Toffler, p. 92; Dunnigan, pp. 126-129.
[53] James Edward McClellan and Harold Dorn, *Science and Technology in World History: An Introduction*, 2nd Edition (Baltimore: Johns Hopkins University Press, 2006), p.11. See also, Appendix A, pp. 255-258.

only imagine, for instance, that Francesco Guicciardini's famous reports of the French bronze cannon used in Italy in 1494 must have quickly done the rounds of the great houses of Europe when he wrote that:

> The French developed many...pieces which were even more manoeuvrable, constructed only of bronze. These were called cannons, and they used iron cannonballs instead of stone as before....and so little time elapsed between one shot and another and the shots were so frequent and so violent was their battering that in a few hours they could accomplish what previously in Italy used to require many days.[54]

Recognition of the advantages of a new weapon is not a trait that is restricted to scientifically literate peoples. The Native Americans of New England, despite having no prior experience with gunpowder weapons, quickly recognized the advantages of a musket over a bow (and even, unlike the majority of colonists, of flintlocks over matchlocks) and set about adopting these new weapons.[55]

Fourth, awareness could be either actively or passively encouraged by change agents. An example of the former is when Einstein and Szilard informed Roosevelt of the possibility of the atomic bomb, and of the latter is the borrowing by the Mongols of the weaponry of their defeated foes, the awareness of which was thus disseminated to all the lands they subsequently traversed.[56] These change agents were sometimes found amongst the technical classes (engineers and scientists), who were wont to exchange their ideas. Other militaries could also serve as change agents, as occurred across various forms of alliance, either voluntarily (for example, the Allies in World War II) or coercively (such as the top-down diffusion seen within the Warsaw Pact).[57]

The channels through which awareness was disseminated also vary considerably, from direct observation (such as through espionage or captured weapons), through written descriptions and printed materials (from the fifteenth century on) up to video recordings and CAD files that can be sent over the Internet today.

One interesting hypothesis suggested by the historical examples presented is that

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[54] Francesco Guicciardini, *Storia d'Italia*, quoted in Hall, p.159.

[55] Appendix A, pp. 283-285; Patrick, M. Malone, *The Skulking Way of War* (Lanham, MD: Madison Books, 2000), p. 35.

[56] McNeil, pp. 59-61.

[57] Christopher Jones, 'Reflections on Mirror Images: Politics and Technology in the Arsenals of the Warsaw Pact', in Goldman and Eliason (eds.), p. 117; Appendix A, pp. 309-310.

awareness of a weapons innovation might be facilitated by certain qualities inherent to the weapon itself or its effects, such as whether the weapon represents a significant departure from previous weapons or whether its effects are easily observable and immediate. The loud bang emanating from the earliest gunpowder weapons and the psychological distress this tended to cause might thus have had something to do with the rapid growth in awareness of (and military perseverance with) these weapons in Europe despite their initially poor performance relative to torsion or tension projectile weapons.[58] It can be hypothesized that in a modern society seemingly obsessed by the latest iPad or other high-technology device, weapons associated with the latest technical breakthroughs or with popular fiction (such as synthetic biological agents) might garner widespread and rapid attention by would-be purveyors of violence. Additionally, weapons whose advantages over existing modes of combat are easily observable and immediate may be more recognizable than those whose benefits are more subtle and the former might thereby engender greater awareness amongst potential adopters.

Factors Influencing Adoption Decisions

The Organizational Decision-Making Context

Identifying the specific decision-makers and the decision-making context surrounding the potential adoption of a weapons innovation is straightforward in certain cases (where authority was highly centralized and records were kept, such as in Ancient Rome or Renaissance Europe) but almost impossible in others (say, among pre-literate societies or highly decentralized polities) and any overarching conclusions must therefore be tempered. However, despite some variation, from the evidence we have the decision-making context for new weapons mostly seems to reflect the broader social, political and organizational structures in place in whichever collectivity is contemplating adoption of an innovation.

Thus, in the most primitive societies, where Darwinian forces applied most directly, it is likely that there was no single decision-maker – each individual or small band made their own weapon adoption decision and lived (or otherwise) with the consequences.

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[58] See McNeill, p. 83 and Keegan, p. 238 for similar ideas.

Widespread adoption under such conditions must have functioned as an emergent process, with innumerable micro-decisions and their consequences resulting in the macro-adoption of a new weapon, such as a flint-topped spear.

As soon as societies recognized some central leadership, it became likely that most adoption decisions vested in the ruling individual, whether this was a chief or a king, with the degree of consultation that was permitted reflecting the nature of the existing polity. Thus it was that through most of history the decision whether or not to adopt a new weapon rested primarily with the ruler, whether this was Alexander the Great, Charles VIII, Tokugawa or Mehmut II. While one cannot rely on counterfactuals, it is debatable, for instance, whether the longbow would ever have secured such a prominent position on European battlegrounds such as Crécy in 1346 and Agincourt in 1415, had not the person of Edward I recognized that the longbow, a favourite Welsh hunting weapon, could be deployed in battle to deliver a dramatic concentration of fire.[59]

This leads to consideration of an important feature that emerges from the historical record, namely that innovation does not always arise completely spontaneously. Although invention depends to at least some extent on individual flashes of insight, weapons innovation need not always come bubbling up organically through the ranks of warriors and military technicians, but is often the result of a top-down institutionalization specifically set up to develop novel weapons. From the Assyrians at Nineveh[60] and Dionysus at Syracuse,[61] to the rulers of Italian city-states, the British Ordnance Boards and the U.S. Defense Advanced Research Projects Agency, such 'directed innovation' has been all too common within the world's militaries.

In many cases, rulers institutionalized the *process* of weapons innovation or of adopting innovations, after which day-to-day decision-making might have been delegated to subordinates or technicians. However, even then the impetus for adoption still usually

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[59] Volkman, p. 44; for more detail see Matthew Strickland and Robert Hardy, *The Great Warbow* (Stroud: Sutton Publishing, 2005).
[60] Volkman, pp. 20-21.
[61] Dionysus, the ruler of the Greek city-state of Syracuse set up a concentrated program of weapons development where 'the ablest skilled workmen had been gathered from everywhere into one place. The high wages, as well as the numerous prizes offered the workmen who were judged to be the best, stimulated their zeal' (Diodorus Sicilius, *Library of History Vol. VI*, translated by C. H. Oldfather (Cambridge, MA: Harvard University Press, 1954), p.131 [Book XIV, Chapter 42]). Among other innovations, Dionysus oversaw the invention of the catapult.

remained with the ruler. Of course, even in the most despotic of societies there were no doubt advisors and other functionaries who commented on practicalities, priests and religious authorities who determined the spiritual suitability of a weapon and elite castes of warriors who jealously guarded their positions, so that it was probably only in the rarest of cases that the ruler's decision was absolute or free from external influences.

Once government became more deliberative and overall decision-making more decentralized, we see adoption decisions made more often by military professionals. Thus, it was the Prussian General Staff under Moltke the Elder that made several important weapons decisions in the mid-nineteenth century, and the British Admiralty that debated the size and nature of its fleet. Bureaucratization continued throughout the twentieth and early twenty-first century, further decentralizing weapons adoption decisions, which became the function of dedicated procurement agencies. In democracies like the United States, the decision-making is especially diffuse, with various military branches, the Executive and various levels of legislative government, together with numerous commercial and other special interest groups, all contributing towards weapons acquisition decisions. This creates a complex web of interactions, coalitions and opposing interests that makes it difficult to determine who has the most influence over the outcome of a particular adoption decision. A further complicating factor is the complexity of modern weapons systems, which invariably ensures that no single decision-maker can have a complete understanding of all the technical, organizational, legal and tactical aspects of most weapons.

One sector that, although rarely exercising direct decision authority, has nonetheless influenced weapons adoption decisions since the earliest times, is the (often civilian) producers of weapons, whether these are individual craftsmen, guilds, entrepreneurial inventors or large multinational corporations. Where these actors were responsible for the supply of existing or potential new weapons, they often sought a voice at some point in the decision process. At times their influence was minimal and indirect (such as royal armourers in medieval Europe), while at other times they exercised considerable influence on adoption decisions (for example, artillery producers in the late nineteenth century or defence contractors in the United States today).

One must not forget the role of weapon champions, those individuals (either military or civilian) that promote a particular weapon or weapons system. While such champions can serve to counterbalance bureaucratic inertia or institutional resistance (for example, in the case of Lieutenant William Sims' direct advocacy to Teddy Roosevelt of continuous aim gunfire in the U.S. Navy), it is also possible that they can harden existing opposition, as seen in the case of Basil Liddell Hart and his espousal of armoured warfare.[62]

Influencing Factors

Beginning at the broadest level, ideological, social and cultural compatibility with an innovation certainly seems to play a role in creating an environment that is either fertile or hostile to new weapons development.[63] An illustrative case is the Japanese rejection of firearms – for more than two hundred years – under the Tokugawa shogunate, which has been at least partly explained by the incongruity between the chemical reactions of firearms and traditional Shinto sentiments regarding harmony with the natural world and the purity of bodily kinetics.[64] The risk aversion and hence general circumspection of military commanders with respect to new weapons, especially for those introduced during the crucible of actual combat, has also been noted.[65] Overall, Goldman and Ross conclude that a military organization's capacity to adapt its doctrine and institutional structure to an innovation is key in the adoption decision, and that this is at least partly dependent on resource levels and the compatibility of the innovation with existing organizational norms.[66]

In terms of those factors that drive weapons innovation, the historical record provides several insights. First, much weapons innovation throughout history has originated from the perceived need to solve a problem not addressed by contemporary weapons, which then drives actors to initiate a process of internal weapons development (or, alternatively, to scan their external environment for solutions). Examples abound, from the development of siege engines by conquerors from Assyrian times in order to assail

[62] Rosen, p. 13
[63] Black, p.1223.
[64] Keegan, pp. 44-45.
[65] Rosen, p.25; Dunnigan, p. 6.
[66] Goldman and Ross, pp. 301-302.

the fortifications of walled cities,[67] to attempts to equip motorized vehicles with tracks and armour to overcome the muddied trenches of the First World War and later efforts to produce guided munitions as a solution to unaffordably high levels of inaccuracy in aerial bombing.

Second, prevailing competition between political entities seems to have been one of the central drivers of weapons innovation, from stone-age peoples[68] to the superpowers of the Cold War. Competition does not only take the form of keeping up with the weapons innovations of rival states, clans or tribes, but it can also – in light of the 'offence-defence' co-evolutionary dynamic described earlier – result in the offence being compelled to progress in order to circumvent robust defence.

Third, issues of status are also no stranger to the realm of weaponry, with the expectation of prestige no doubt playing at least some role in many adoption decisions. This is amply illustrated by the often (literally) ludicrous lengths to which medieval European armourers went to create ever larger, more elaborate and arguably less functional swords, not to mention the proverbial 'pissing contest' between Germany and Great Britain over the size and complexity of warships at the turn of the twentieth century.[69] Advancements in technology may only exacerbate this dynamic, as is perhaps demonstrated by several of the more recent acquirers of nuclear weapons or the sometimes preposterous purchases by small yet wealthy states of more fighter jets than they have available pilots for.

Fourth, sometimes the availability of a new weapon provokes a search for ways to use it, even when no previously articulated need existed, a situation that Joel Mokyr captures by inverting the popular aphorism to describe 'invention as the mother of necessity'.[70] This can also occur when new scientific or technological discoveries (often

[67] Thucydides provides a superb contemporary description of the tribulations associated with attempting to overcome the dedicated defence of a city in a *History of the Peloponnesian Wars* (sections 2.75, 2.76 and 4.100), where both the besieged and the besieger worked hard to undermine (sometimes literally) each other's constructions.
[68] John Keegan (pp. 26-27), for example, ably describes the rapid production and diffusion of the *mata'a*, a more lethal spearhead, on Easter Island during a time of heightened internecine discord.
[69] In this vein, Dennis Showalter describes Prussian gunners as possessing 'a certain gigantism' in which heavier artillery was preferred even if it was not as effective or efficient as smaller cannon (Dennis Showalter, 'Weapons and Ideas in the Prussian Army from Frederick the Great to Moltke the Elder', in J.A. Lynn (ed.), p. 189).
[70] Mokyr (1990), p.151.

in the civilian world) prompt the creation of new weapons. The canonical example of this would be the Manhattan Project, where the tremendous advances in nuclear physics in the 1920s and 1930s were brought to military and political leaders' attention, eventually spawning the development of the atomic bomb.

Last, there is the possibility that weapons innovation can arise somewhat spontaneously, without a conscious driver. In this case trial and error or curious tinkering results in existing (or newly discovered) objects or practices being put to new purposes, thus creating novel weapons. A prominent example is the development of the first cannon, which first came on the scene around two centuries after the appearance of gunpowder.[71] This might also transpire when innovation becomes so institutionalized within a large bureaucracy that it occurs for its own sake, without any overall organizational awareness that it is occurring or relationship to the external environment. While rare in its pure form, there are instances within the defence establishments of major powers within the past half-century where one might argue that such 'blind innovation' occurred without complete cognizance thereof. For example, Van Creveld points towards Ballistic Missile Defence as a recent example of an innovation that was 'driven less by any clear idea as to [its] usefulness or even desirability than by the foibles of the powers that be'.[72] In such situations, it has been argued that 'technological innovation [became] largely unaffected by the activities of potential enemies, [and] a rather self-contained process'.[73]

Factors Influencing Adoption Success

The extent to which a weapons innovation is successfully adopted by the receiving entity and the time until the process is effectively complete[74] varies considerably across time periods and societies, but historical cases give some indication of the structural factors that can impede or facilitate a successful outcome. In this regard, 'success' connotes that the new weapon or weapon system performs at least as well as the model

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[71] Kenneth Chase, *Firearms: A Global History to 1700* (Cambridge: Cambridge University Press, 2003), pp. 31–32; Lu Gwei-Djen, Joseph Needham, and Phan Chi-Hsing, 'The Oldest Representation of a Bombard', *Technology and Culture*, 29:3 (July 1988), pp. 594-605.
[72] Van Creveld, p. 260.
[73] Rosen, p. 250.
[74] The term 'effectively complete', refers to the point where the innovation has not only been physically adopted, but also incorporated into combat systems, doctrine and training; in other words when it is capable of being fielded in combat to the extent where its intended advantages can be brought to bear.

or models that prompted the adoption, or in the absence thereof, providing a similar level of military benefit as initially envisaged by the adopting entity.

An overarching determinant of the successful adoption of a weapons innovation has been described by several scholars[75] and flows naturally from the fact that all innovations, by definition, entail a human or social dimension. Successful adoption requires not only developing or acquiring the physical weapon itself (the ‘hardware’), but also incorporating the logistical, organizational, doctrinal, training and sometimes even broader social changes required for the adopted weapon to function effectively (the ‘software’).[76] Several cases of partially or wholly unsuccessful adoption of weapons innovation have been attributed to a failure to imbue the hardware with the required software, including the lacklustre attempts by several European countries to imitate Prussian combat arms in the latter part of the nineteenth century and the no less ineffectual attempts by Arab nations to adopt advanced tanks in the latter part of the twentieth.[77]

The historical record provides several categories of obstacle to adopting both the hardware and the software components of a weapons innovation. Perhaps the most obvious is a lack of the requisite materials or resources to produce sufficient quantities of the new weapon. This may have been one of the major reasons why the Ancient Egyptians, who did not have access to copious quantities of the materials to make bronze, were still employing clubs and stone-tipped spears at the start of the Middle Kingdom (approximately 2000 BCE),[78] despite the Bronze Age being well underway, and the lack of raw materials certainly limited the spread of gunpowder weapons in the fourteenth century. A second, related, obstacle revealed by the record is not having sufficient and sufficiently skilled human capital to produce, service and use the new weapon system. The lack of large numbers of available highly-trained archers in fourteenth century continental Europe, for example, at times hindered the large-scale

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[75] Steele and Dorland, pp. 16-17; Boot, pp.88-89; Hoyt, ‘Revolution and Counter-Revolution: The Role of the Periphery in Technological and Conceptual Innovation’, in Goldman and Eliason (eds.), p.200; Goldman and Ross, pp. 382-384; and Van Creveld, p.156.
[76] This is related to the knowledge concepts of *techne* and *metis*, which will be discussed fully in Chapter 3.
[77] See Appendix A, p. 297; Michael J. Eisenstadt and Kenneth Pollack, ‘Armies of Snow and Armies of Sand: The Impact of Soviet Military Doctrine on Arab Militaries’ in Goldman and Eliason (eds.), pp. 91-92.
[78] Barry Kemp, *Ancient Egypt: Anatomy of a Civilization* (London: Routledge, 1983), p. 269.

adoption of the longbow.[79]

Occasionally, there are tactical constraints to be considered when adopting new weapons. Taking account of the physical terrain, for one, is important; chariots, for instance, are of little use on uneven ground. Military or political leaders must also take into consideration the support systems required in order to field the new weapon. It is trite to state that artillery requires ammunition, trains require tracks and most strategic bombers require mid-air refuelling, but if the infrastructure to supply these requirements does not exist, then the weapons are useless. This, together with command, doctrine and organization, is the essence of what is meant by a weapons system – if actors pay insufficient attention to the mundane considerations of support amid the more dynamic elements of a weapons system, the new weapon will likely function sub-optimally, if at all.

While cultural encumbrances to either innovation in general or the adoption of a specific weapons system can lead to a decision not to adopt, oftentimes the cultural resistance does not apply to the physical weapons themselves, but to the social changes that successful adoption requires and thus affect the software aspects of the adoption process. Several militaries have been unable to make the social and organizational adjustments necessary to effectively adopt firearms because of cultural incompatibilities. One such example is the half-hearted attempts by the ruling Mamluks of Egypt to employ gunpowder weapons (the Mamluks viewed firearms as beneath them and used traditional weapons themselves while recruiting gunners and musketeers from black Africans and people of the Maghreb) and their consequent ignominious defeats at the hands of the Ottomans in the battles of Marj Dabiq (1515) and Raydania (1516).[80] The difficulties that the Muslim world experienced in effectively integrating gunpowder weapons in the sixteenth through nineteenth centuries can thus be attributed in large part to discordance between traditional religious values and the required emulation of Western social structures. The presence of cases of cultural incompatibility should not, however, be taken as a universal phenomenon – the Native Americans accepted firearms with alacrity and incorporated them more or less seamlessly into existing cultural traditions[81] and the Japanese, when they eventually decided to borrow

[79] Appendix A, p. 267.
[80] Keegan, p. 36; Parker, pp. 126-127; Appendix A, pp. 280-282.
[81] Malone, *passim*.

Western technology on a wide scale, managed to merge traditional concepts with modern warfare, an obvious example being the *kamikaze* bombers of the War in the Pacific.

Related to, but often distinct from, cultural impediments is resistance to innovation by conservative elites or other interests in the adopting entity who are vested in the status quo and push back against an innovation despite its military utility. Military organizations, with their intrinsic orientation towards obedience, discipline, martial values[82] and routinization, are held up as being particularly prone to elicit internal opposition to change, especially those changes that originate outside of the military establishment.[83] Possibly the most cited example of this is the resistance of horse-drawn charioteers and later horse-mounted knights to the introduction of infantry weapons that might challenge their supremacy on the battlefield and hence their elite status,[84] but it was also seen in more modern times with the resistance of many military commanders to concepts of mass mechanized warfare prior to World War II.[85] Conservatism need not arise from selfish or parochial motives – even an unwarranted degree of risk aversion in an otherwise dedicated commander can lead to forswearing a potentially useful weapon, as witnessed by Wellington's dismissal of Congreve rockets.[86]

Examining these obstacles and pitfalls by contrast illuminates factors that promote successful adoption of weapons innovation. These include: a) the availability of sufficient human and material resources, preferably with a significant devotion of personnel and economic capital; b) cultural compatibility with innovation in general and the candidate weapon system in particular; and c) institutional and doctrinal flexibility and receptivity to even fundamental changes in practice. While none of these factors are necessary or sufficient for weapons adoption, they cumulatively increase the likelihood of a successful outcome.

A high threat environment might encourage the decision to adopt, but does not necessarily seem to be closely correlated with successful adoption outcomes, as several

[82] The argument here is that these values create a cultural barrier between the armed forces and the rest of society, one that breeds insularity and an inherent distrust of new developments, especially those emerging from non-military innovators.
[83] Keegan, p. xvi; Hall, pp. 4-5; Rosen, p. 19 and Van Creveld, p.220.
[84] Hall, pp.4-5.
[85] Appendix A, pp. 298-301.
[86] Appendix A, pp. 288-289.

prominent historical cases reflect failed adoption in the presence of extremely motivated adopters facing significant threats to their survival. An example is the willingness but continued inability on the part of South Asia's indigenous militaries to properly incorporate gunpowder weapons into their military doctrine, as demonstrated by the ineffective performance of the artillery of the Maratha Confederacy in the Battle of Assaye (1813).[87] Nonetheless, the successful diffusion of a new weapon does seem to be correlated with the extent of perceived benefits (or the military costs of non-adoption), as well as the amount of resources made available for implementation of the adoption process, both of which are dependent to some extent on prevailing perceived threat levels. One must not forget, however, that, as described above, cultural or ideological incompatibilities, bureaucratic inertia or inter-organizational 'turf battles' can vitiate the adoption process irrespective of the relative advantage of the weapon.

Moreover, the adoption of a novel weapon may not only require structural and doctrinal adjustments by the adopter in order to function properly, but the weapon can itself undergo substantial changes as it in a sense adapts to and is adapted by a new organizational environment, often by means of extensive improvisation. Thus, all weapons innovations are in some ways unique, since they emerge into a specific social moment and evolve in a specific adoption context.

One further note – although adoption of new weapons sometimes requires the adoption of entirely new systems or platforms (such as the advent of combat aircraft) or complete displacement of existing weapons (the socket bayonet replacing the pike), the adoption process need not be wholesale. Old and new forms can coexist, as seen most spectacularly in the oar-and-sail and sail-and-steam warship hybrids in the naval sphere.

In terms of the speed with which the adoption of a new weapon takes place, this is obviously dependent to a large extent on the nature and complexity of the weapon and the technical and operational status of the adopter. Nonetheless, the speed of adoption also seems proportionate to the perceived advantages of the new weapon (or disadvantages from not possessing it), and the resources devoted to the adoption process, both of which can be affected by the level of threat perceived by the adopting

[87] *Vide*, Arthur Wellesley to Henry Wellesley, October 3, 1802, in John Gurwood (ed.) *The Dispatches of Field Marshal the Duke of Wellington During His Various Campaigns in India, Denmark, Portugal, Spain, the Low Countries, and France, from 1799 to 1818*, Vols. I-II (London: John Murray, 1834).

entity. The Manhattan Project is the archetypical example of resource dedication resulting in rapid advances and adoption in a relatively short time span, whereas the Israelis, who operate in a high-threat environment, have on occasion developed weapons systems (including ship-to-ship missiles and unmanned aerial vehicles) more quickly than much larger and more powerful nations.[88] Moreover, the adoption of military innovations is argued to be facilitated by cultural or other affinities between the military or political leadership in the innovating and potential adopter states, and hampered by dissimilarities.[89]

One feature that can impact both the success and speed of weapons adoption is conscious action by the current holders of the weapon to prevent its spread. Such efforts can be as simple as keeping the technology a closely-guarded secret (as in the case of the Byzantines and Greek fire) or as extensive as collaborative agreements across states to deny the requisite knowledge and materials to produce the new weapon or weapons system. In any event, whether it is attempts to keep firearms out of the hands of 'natives' or the creation of global non-proliferation regimes to stop the spread of WMD, these efforts seem to be common wherever the current possessors of a new weapons system believe it feasible to preserve their advantages over enemies or potential enemies.

Theories and the Historical Record

It remains to revisit the various theories introduced above, in light of the historical survey. To address the most structural, deterministic theory first, it is immediately evident that there is much in the historical record to recommend the neorealist approach. Time and again, the rulers of kingdoms and states sought to adopt any weapon that threatened to give an opponent or potential opponent a significant military advantage, and thereby to redress any perceived deviations from the pre-existing balance of power.[90] As predicted by the theory, history bears witness to several arms races wherein powers of similar strength vie to stay ahead of one another in the quantity, but also type,

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[88] Hoyt, pp.183-188.
[89] Eliason and Goldman, pp. 15-16.
[90] Appendix A offers several relevant cases, two of the most unequivocal being the scramble to adopt bronze artillery in fifteenth century Europe and the widespread adoption of breechloading rifles in the nineteenth century following the Prussian example.

of weapons, seminal examples being late nineteenth century warship construction and the nuclear competition of the Cold War. The ubiquity of certain basic weapons and the overall similarity in armaments among powers of similar strength lend further support to the theory.

However, the record also contains much that is problematic for the neorealist theory of weapons adoption as part of a broader dynamic of inter-state competition, at least in that theory's most basic, unmodified form. The simple fact that history is replete with examples of political entities who chose not to adopt the latest innovations in weaponry despite their military benefit should lead to some pause, because in order for the theory to remain consistent, the leaders of each of these entities must have either lacked the capacity for adoption or the basic reasoning faculties to understand that adoption is a strategic necessity. Neither of these alternatives explains, for instance, the tacit agreement between mounted horsemen of the South Asian kingdoms to make cavalry the centrepiece of battle[91] or the ritualization of combat among 'primitive' warriors, such as those of the Yanomamö, Maring and Aztec.[92] Even were we to take the position that these examples fall outside of the sort of 'civilized' warfare among modern nation-states to which the theory was designed to apply, there are many recent examples of states rejecting those weapons systems that would have been most strategically beneficial because of internal rivalries or domestic interests.

The theory also predicts *rapid* adoption of strategically beneficial weapons innovations to regain parity of arms with competitors, but in many cases internal resistance slowed the adoption process, which became drawn out over decades or centuries. The existence of other means whereby nations can pursue security besides parity in the type of weapons they can field, such as bandwagoning or developing economic and other interdependencies, raises further questions for the theory, as do the numerous examples where those who were not leading-edge adopters (such as the Mongols) nonetheless managed to exert power in the international system for extended periods. Neorealist theories of weapons adoption also experience some difficulty when faced with military decisions to devote substantial resources towards strategically marginal weapons for purposes of prestige (such as the Soviet interwar pursuit of an aircraft carrier), although

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[91] G. J. Bryant, 'Asymmetric Warfare: The British Experience in Eighteenth-Century India', *Journal of Military History*, 68:2 (April, 2004), p. 469.
[92] Keegan, pp. 95-114.

in this case the adoption can also be explained in terms of signalling behaviour. Explanation becomes harder when key decision makers push for adopting a new weapon primarily because they possess a fascination with the weapon concerned. Lastly, naked neorealism posits that weapons innovations will flow from the major to the peripheral powers in the international system, but the reverse has also sometimes been seen. For example, in the case of guided weapons, innovations developed by the Israelis spread to the United States and even the first Congreve rockets had their origins in India.

Therefore, while the neorealist argument lays down the basic logic of weapons innovation and diffusion, and thus describes the 'background driving force' operative in the international system that stimulates the adoption of new weapons, the basic approach needs to be supplemented with several other factors that can facilitate, retard or otherwise influence adoption decisions. As discussed above, there is ample evidence to support those theoretical approaches that emphasize consideration of the distinctive cultural and institutional make-up of the adopting entity, including the fertile or hostile reaction to the new weapon based on its compatibility with the dominant culture, the effect of internal rivalries and the need to overcome a bureaucratic inertia that tends to be especially pronounced and widespread in the military domain. The inclusion of these latter factors into the basic theory will no doubt lead to an adoption decision model with far greater explanatory power over a broader set of actors and time periods.

Applicability to the Terrorist Context

Before appropriating the conclusions derived above for the current investigation, some consideration should be given to their likely applicability to terrorist behaviour, especially since much of the historiography of weapons innovation and diffusion centres on the behaviour of states or similar large political collectivities. Certain findings relate to the nature of the weapons themselves, such as the relevance of a cumulative set of incremental improvements or the mechanisms for becoming aware of innovations, and can thus be expected to apply to a wide range of adopters, including non-state actors such as terrorists. Other findings, particularly those dealing with decision-making and organizational structure, may have to be modified for the terrorism context, or perhaps discarded entirely. In order to guide in the construction of a reliable model of terrorist adoption of new weapon technologies, the following highlights those aspects of the above discussion that might differ when applied to the terrorist context.

First and most obviously, terrorists often experience constraints – such as the need to remain hidden and a constant fear of arrest, or worse – that most militaries do not face, at least not during times of peace. Terrorist weapons are therefore usually limited in physical dimensions to those that are relatively small, light and easily concealable.[93] Second, terrorists cannot compete with states in any literal sense, since they almost always lack the material resources, territory and legal recognition within the international system enjoyed by even the weakest of states. Terrorist groups therefore can almost never act to 'balance power' against states as neorealist theory maintains and probably will not be driven to adopt new weapons because of a fear that the state will get them first. The basic neorealist argument is thus unlikely to be the primary driver in terrorist decisions about which weapons to adopt. Other factors must therefore be looked to besides neorealist power balancing, yet terrorist organizations do on occasion compete against each other and against other types of protest groups for the support of a variety of constituencies.[94] Thus, the dynamic of adopting a novel weapon as a means of offsetting an advantage of a rival might apply in some instances. Here, though, the advantage would be the amount of support the organization receives rather than a military advantage.

Also, while the efficacy of new weapons systems adopted by states is evaluated mainly by battlefield performance, terrorists mostly have a more complex set of criteria for success. As asymmetric opponents who seek to influence a spectrum of audiences beyond the immediate victims of their violence, terrorists are likely to place greater emphasis than would be common in the state context on the psychological effects of a new weapon and its potential as a force multiplier in its evaluation of a prospective weapon.[95]

In terms of the actors themselves, terrorist groups are at their core organizations, albeit

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[93] Van Creveld, p. 306.
[94] Mia Bloom, *Dying to Kill: The Allure of Suicide Terror* (New York: Columbia University Press, 2005); John Sawyer, *Competition in the Market for Political Violence: Northern Irish Republicanism, 1969-1998* (PhD diss., Georgetown University, 2010).
[95] For a discussion of terrorism as a means of psychological combat, see, *inter alia*, Daniel Gressang IV, 'Audience and Message: Assessing Terrorist WMD Potential', *Terrorism and Political Violence* 13:3 (Fall 2001), pp. 88-89; Drake, pp. 42, 181; Hoffman (1997), pp. 2, 8.

sometimes loosely structured ones, and therefore are susceptible to many of the same dynamics that affect all organizations, including internal rivalries and some degree of institutional inertia. However, most terrorist organizations display less bureaucratization, smaller hierarchies, and greater decentralization than modern military organizations.[96] They also often consist of charismatic leaders who dominate at least the strategic aspects of decision-making together with fanatically devoted followers rather than an impartial, 'professional' standing force.[97] For all these reasons, in the weapons adoption process terrorists may more closely resemble armed forces from earlier times than those of today and special attention should be paid to premodern experiences in seeking lessons, particularly those related to the organizational aspects of weapons adoption.

Unlike most militaries, terrorists do not distinguish between the front and the rear in terms of operations, nor do they usually think in terms of individual battles. Instead, all aspects of the enemy society often become targets in a long, epic struggle. Paradoxically, this long-term outlook, tactical flexibility and extended planning horizon mean that some terrorist groups might engage in protracted weapons development activities that closely parallel the R&D activities of the largest states, which in turn may hold clues as to how terrorists might behave during long-term weapons development or adoption.

By considering the theories and history of weapons development and adoption, this chapter has helped to limn the range of possible precipitants and outcomes, suggest regularities in the adoption process, provide a comparative backdrop for current developments, and in so doing equip us with a foundation upon which to construct a theory of terrorist weapons adoption. The analysis of the historical record has revealed some of the basic elements of decision-making and implementation surrounding the adoption of innovations in weaponry. It has also highlighted some of the peculiarities that attend the diffusion of weapons in particular and has provided a set of broad

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[96] For example, of a sample of 58 terrorist organizations active in 2011, 34% consisted of horizontal networks, whereas 43% were structured as vertical hierarchies, which is clearly far less than for organized militaries. See Gary Ackerman and Lauren Pinson, *Profiles of Incidents Involving CBRN and Non-State Actors Database – Organizational Coding* (College Park, Maryland: National Consortium for the Study of Terrorism and Responses to Terrorism, 2012).

[97] In many ways terrorists are imbued with what can be termed a 'warrior spirit' thriving on conflict, which Thomas Hammes distinguishes from the modern soldier (Thomas X. Hammes, *The Sling and the Stone* (Minneapolis: Zenith Press, 2006), p. 41).

parameters that constrain, regulate and drive weapons adoption. The next step in formulating a model of terrorist weapons adoption is to build on these historical insights by investigating the decision-making from the innovator's point of view, and that of terrorists in particular.

Chapter 3: Terrorists and Innovation[1]

The previous chapter focused on the history of weapons and how instruments of war have been adopted over the millennia. This chapter now turns to an exploration of the other side of the coin – terrorist organizations themselves and how they innovate in general. As discussed in the introductory chapter, until recently there has been relatively meagre scholarly study of how innovation and learning occur in terrorist organizations. Outside the rather narrow corridors of terrorism studies, however, there is an immense corpus of prior work on innovation in other domains, not only in the military context, but more generally in disciplines as diverse as business management, public policy and sociology. This vast literature incorporates a treasure trove of insights relating to innovation in a variety of human activities, but has remained largely untapped by terrorism researchers; to all appearances there has been only a single attempt by a scholar of terrorism – and a partial one at that – to systematically draw on innovation research in the broader social and behavioural sciences.[2] This is somewhat odd, considering that, at their most basic, terrorists are human beings and terrorist groups are social organizations, so there is a *prima facie* case to be made that this wider body of literature is relevant to the terrorist context.

This chapter will therefore proceed with the 'inside out' approach of the study by highlighting the prominent findings on terrorist innovation, while supplementing them with findings and theories drawn from organizational innovation and learning in the general innovation literature. Of course, there is no expectation that theories or results found outside of the terrorism domain will address all aspects of interest to this study, but they may very well provide signposts for where the answers to the study's questions might lie. Furthermore, just as in the previous chapter, one must be cautious in applying analogical insights from outside the terrorism context because of the differences between terrorist actors and other types of entities.

[1] Earlier versions and elements of this chapter have been utilized in Gary Ackerman, 'Understanding Terrorist Innovation Through the Broader Innovation Context', in Rasmussen and Hafez (eds.); Gary Ackerman, 'The Theoretical Underpinnings of Terrorist Innovation Decisions', Conference Paper Prepared for the *Swedish National Defence Centre Seminar on Terrorist Innovation and Learning*, Stockholm, Sweden (26 June 2012); and Gary Ackerman and John Sawyer, *Embracing Technologies of Lethality*.
[2] The only attempt to explicitly relate broader insights of innovation to the terrorism realm of which the author is aware has been that of Brian Jackson and even then his discussion was limited to the domains of technology adoption and private sector behaviour (Jackson (2001), *passim*).

The structure of the chapter will broadly parallel that of the previous chapter by following the major stages of the adoption process, i.e., awareness of innovation, the adoption decision and the determinants of success, as well as addressing similar subtopics where these are applicable to a focus on actors as opposed to instruments. The chapter will end with an analogue of the final section of the previous chapter, only instead of dealing with the applicability of general weapons adoption factors to terrorism, it will discuss terrorist innovation as this applies to weapons in particular.

Awareness of Innovation Possibilities

Characterization of Terrorist Innovation

Adoption of an innovation can only proceed if a terrorist organization becomes aware of an alternative to those tactics currently being used or those weapons presently in its arsenal. Recognition that another option is available is an inherently subjective determination, implying that what might be regarded as a potential weapons innovation by one terrorist actor might not be by another organization or individual decision-maker.[3] Moreover, it also means that this stage of the adoption process can be affected by cognitive and other individual and group biases, including confirmatory bias, where actors might 'filter out' ideas that are not concordant with their values, heuristics or existing routines.[4] An important note in this regard is that because most technological innovations in particular are in essence recombinant (i.e., made up of novel combinations of prior technologies[5]), a terrorist organization need not possess a genius inventor in order to adopt a new weapon or tactic, but can engage in this sort of innovation so long as it is able to survey existing methods and materials and conceive of novel ways of combining them to suit organizational or personal goals.

Mechanisms of Awareness

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[3] Everett Rogers, one of the seminal scholars of innovation diffusion, defined an innovation in these terms as 'an idea, practice, or object that is perceived as new by an individual or another unit of adoption' (Everett Rogers, *Diffusion of Innovations,* 5th ed. (New York: Free Press, 2003)). He reiterates this by stating explicitly that 'if an idea seems new to the individual, it is an innovation' (p. 12).
[4] Rogers (2003), p. 171.
[5] Brian Arthur, *The Nature of Technology: What It Is and How It Evolves* (New York: Free Press, 2009), p. 19.

The first mechanism by which terrorists might become aware of candidate innovations for adoption is through a self-initiated search after a realization by terrorist leaders that there is an operational or strategic need that is unmet by existing capabilities (*active searching*). There are many cases of terrorists proactively seeking out new weapons or tactics, from the Provisional Irish Republican Army (PIRA) deciding that it required its own mortars, to Prabhakaran's desire to equip the Tamil Tigers (LTTE) with a seaborne attack capability through his 'Sea Tigers' fleet of self-constructed fast attack boats.

The prospects for a self-initiated search for new means and methods of attack will undoubtedly be coloured by existing organizational or ideological predispositions towards or against innovation in general. The anarchists and early socialists, for instance, clearly believed that it was necessary to stay abreast of the latest scientific and technical developments in the hope of acquiring new weapons technologies, as seen in the declaration by a speaker at the Fifth Conference of Social Revolutionaries in 1909 that 'Terror will be terror in the true sense of the word only if it represents the revolutionary implementation of the most advanced technical sciences at any given moment'.[6]

The second avenue by which knowledge of new operational procedures or technologies might reach a terrorist organization or individual is through demonstration of their usefulness or potential usefulness in the external environment (*demonstration*). This can obviously occur when other terrorist groups successfully employ a new weapon or tactic. One particularly salient example of innovation awareness by demonstration is the spread of suicide terrorism from Hezbollah in Lebanon to groups as far removed as the Tamil Tigers in Sri Lanka. It might also occur when a capability is used by non-terrorist actors such as states, or conceivably when a new technology with weapons potential appears in commercial markets.[7]

The third major mode by which a terrorist organization might become aware of a new weapon or tactic is through the conscious efforts of external actors seeking to encourage the adoption of a particular *modus operandi*, weapon or weapons system

[6] David Ronfeldt and William Sater, *The Mindsets of High-Technology Terrorists: Future Implications from an Historical Analog* (Santa Monica, CA: RAND, 1981), p. 1.
[7] For a comprehensive introduction to the early work on terrorist contagion effects, see Yonah Alexander and John M. Gleason (eds.), *Behavioral and Quantitative Perspectives on Terrorism* (New York: Pergamon Press, 1981).

(*proselytization*).[8] The general innovation literature emphasizes that social bias can also come into play here, where a previous adopter of an innovation, having already expended resources on adopting it, will be more likely to extol its virtues than to highlight its deficiencies.[9,10]

The channels through which terrorist groups gain awareness and knowledge of innovations depend to some extent on the mechanism by which the awareness is gained, but can include a variety of means. These range from direct observation of a collaborator's use of a weapon or tactic, through written descriptions in electronic or printed manuals, and even to broadcast media, such as when new weapons are discussed in the press or on television, or other terrorist groups produce YouTube videos of their latest operations. The general innovation literature, based largely on observations of commercial enterprises, suggests that mass-media communications channels are more effective at creating awareness of an innovation, while interpersonal ties are better avenues for actually persuading an entity to adopt an innovation.[11] Although the Internet and other modern communications technologies enable even isolated terrorist groups to have access to copious amounts of information,[12] the ubiquity of communications media does not guarantee awareness or interest in any particular capability. For example, Stenersen notes that CBRN weapons receive very little attention among al-Qaeda's online followers and even those knowledge objects (including manuals and discussion threads) that are available indicate a lack of knowledge of these weapons among jihadists.[13] At the same time, there has been little research even in the general innovation diffusion literature on certain key aspects of information flows in this context, such as whether it is more important for a potential adopter to observe first-hand an innovation in operation, versus hearing about it second-hand through a variety

[8] For more on the role of external facilitators, see the discussion of change agents and opinion leaders below.
[9] David Strang and Michael W. Macy, 'In Search of Excellence: Fads, Success Stories, and Adaptive Emulation', *American Journal of Sociology,* 107 (2001), p. 155.
[10] There is a fourth mechanism of awareness, which, although exceedingly rare, has, as we will see below, been observed within terrorist organizations, namely the possibility that tinkerers within a terrorist organization might stumble upon a new weapon without a conscious intention to do so. This is likely to be more common among lone actors than formal organizations.
[11] David Strang and Sarah Soule, 'Diffusion in Organizations and Social Movements: From Hybrid Corn to Poison Pills', *Annual Review of Sociology*, 24 (1998), pp. 270-272; Mark S. Granovetter, 'The Strength of Weak Ties', *American Journal of Sociology*, 78:6 (May 1973), p. 1360; Andrew Hargadon, *How Breakthroughs Happen: The Surprising Truth about How Companies Innovate* (Boston: Harvard Business School Publishing Corporation, 2003), p. 59.
[12] Dolnik, p. 167.
[13] Stenersen, p. 51.

of media.

Several factors might act to facilitate or retard the possibility of a terrorist organization becoming aware of a novel capability. In the general literature on the spread of innovations, it has been found that networks of actors facilitate the diffusion of knowledge about an innovation to others within their network.[14] There is no reason to conclude that a similar dynamic does not operate within networks of terrorist groups, especially when one considers the relative alacrity with which new techniques for constructing IEDs spread from jihadist insurgents in Iraq to those in Afghanistan in the past decade. This is related to the idea that knowledge tends to spread more easily across organizations sharing similar cultures and objectives.[15] Conversely, divergent cultures and aims can, in general, impede the transfer of knowledge, but do not necessarily do so.[16] Infrastructural and political barriers in the broader society within which an organization is located can also hamper information flows.[17] Crucially, knowledge of a new weapon or tactic can be expected to be easier to come by for a terrorist group that generally functions as what James Forest and others characterize overall as a 'learning [terrorist] organization', i.e., one that appears to possess the 'ability to identify knowledge useful to its long-term success and incorporate that knowledge into the operations and future plans of the organization'.[18]

Information about a new weapon or tactic is, however, regarded as being of little value to a terrorist group without the subsequent step of interpreting this information.[19] Interpretation assigns meaning to the raw information about the new weapon or tactic, and is described by Jackson, et. al. as consisting of making judgments about the value of the terrorist group's current activities, its possible future activities and the continued

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[14] Walter W. Powell, 'Neither Market nor Hierarchy: Network Forms of Organization', in Barry M. Staw and L.L. Cummings (eds.), *Research in Organizational Behavior 12* (Greenwich, Connecticut: JAI Press, 1990), pp. 295-336; Hargadon, p. 60; and Henry Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston: Harvard Business School Press, 2003).
[15] Georges Romme and Ron Dillen, 'Mapping the Landscaping of Organizational Learning', *European Management Journal,* 15:1 (1997), pp. 68-78, cited in Brian A. Jackson et al., *Aptitude for Destruction Vol. 1*.
[16] Barbara Levitt and James G. March, 'Organizational Learning', *Annual Review of Sociology 14* (1988), pp. 319-340.
[17] Committee on Forecasting Future Disruptive Technologies, *Persistent Forecasting of Disruptive Technologies* (Washington, D. C.: National Research Council, 2009).
[18] James J. F. Forest, 'Introduction', in Forest (2006), p. 18.
[19] Horacio Trujillo and Brian A. Jackson, 'Organizational Learning and Terrorist Groups', in Forest (2006), p. 57.

relevance of older knowledge and practices.[20] Important factors affecting a terrorist group's ability to effectively interpret new information include an existing knowledge base to make sense of the information; sufficient time and opportunity to properly consider the information; the breadth of distribution of information within the organization; the extent to which members share common frames of reference; and the depth and feedback speed of the channels through which the information is transmitted to and within the group.[21]

Factors Influencing Adoption Decisions

The Organizational Decision-Making Context

Assuming that the terrorist group is aware of an innovation opportunity and has the minimal organizational capacity for tactical or strategic decision-making, it faces the choice of whether or not to attempt to pursue the innovation.[22] Although it might very well be that 'technological gimmicks have long fired terrorist imaginations',[23] it is also evident – as discussed in the opening chapter – that terrorists rarely, if ever, innovate solely for the sake of innovating.[24] This implies that the adoption of new weapons or tactics is the result of a decision (though not necessarily a completely rational one) that devoting the time and effort to incorporate a new technology or practice that may or may not bear fruit is preferable to expending those same resources on maintaining or expanding existing capabilities.[25] The motivational factors that occasionally coalesce to overcome the inertia against terrorist adoption of new technologies of lethality therefore require exposition, as do the erstwhile adopters' strategic and operational conceptions of new weapons or tactics.[26]

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[20] Jackson et al., *Aptitude for Destruction Vol. 1*, pp. 12-13.
[21] Jackson et al., *Aptitude for Destruction Vol. 1*, pp. 12-13; Trujillo and Jackson, p. 57.
[22] This is not always a binary choice between adoption and rejection. Cragin, et al. (p. 14) point out that the choice can often be whether to adopt now or postpone adoption (i.e. defer) to a later date. More strictly speaking, then, a binary version of the choice facing terrorists is whether or not to pursue adoption at the current strategic juncture.
[23] Stephen Maurer, 'Introduction: Worrying about WMD Terrorism', in Maurer, p. 7.
[24] Jackson (2001), p. 189.
[25] Cf. Waller and George's discussion regarding uncertainties and opportunity costs with respect to familiar versus exotic weaponry (Waller and George, *passim*).
[26] One of the only extant lists of factors influencing the decision to adopt new weapons or tactics can be found in Cragin, et. al., p. 15, but the provided factors, while consistent with those presented below, are arguably overly broad and provide far less specific insights than are required for the purposes of the current study.

Although the extant terrorism studies literature does not explicitly address who makes innovation decisions, it can be expected that the ultimate arbiter of the decision whether or not to innovate will be dependent almost entirely upon the overall command structures within the organization, which vary greatly both across and within the different forms of terrorist organization. These can range from highly decentralized networks where the commander of each subgroup retains the authority to make tactical decisions (including those related to innovation) and only relies on the larger network for strategic or ideological guidance, to very hierarchical organizations, where decisions are held tightly in the hands of a single charismatic leader. In both types of organizational structure, as well as the numerous hybrid terrorist group structures that have emerged, such decisions can also be devolved to operational commanders or technical specialists, either generally or under a specified set of circumstances. This becomes more likely in larger, more complex organizations.[27]

Thus, it is almost impossible to specify in the abstract, without identifying a particular terrorist organization, exactly who will be imbued with decision-making authority over innovations. For example, just as has occurred in many other innovation contexts, an internally initiated search for a new competency might originate either from lower organizational levels, as field or cell commanders recognize an operational deficit, or as the result of a top-down, semi- or fully-institutionalized process whereby leaders explicitly set up an infrastructure to develop new capabilities or issue a command to pursue a specific innovation. While it is rare for *all* decision-making authority in any organization to reside in a single individual without other parties exercising at least some influence, an especially important feature is likely to be whether any actors in the organization possess negative decision-making authority, i.e., are able to veto innovation decisions, which can constrain the alternatives that are considered and shape the agenda.[28] This suggests, as we will see below, that while there may be wide variety in who makes innovation decisions across terrorist organizations, the nature of the decision-maker unquestionably exerts a great deal of influence on the outcome of the decision.

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[27] John Sawyer, 'Decision Makers and the Structure of the Decision Process' in Ackerman and Sawyer, p. 11.
[28] See George Tsebelis, *Veto Players: How Political Institutions Work* (Princeton: Princeton University Press, 2002), cited in Sawyer, 'Decision Makers', p. 10.

Influencing Factors

At least at an operational level, terrorists are widely regarded as employing some sort of decision calculus, albeit on occasion one appearing to bear little resemblance to formal decision-theoretic analysis.[29] This leads to contemplation of the familiar rational choice paradigm, which pervades much of the literature on innovation more generally. From a broad perspective, this approach implies that terrorist groups operating with absolute pragmatism will innovate when they are dissatisfied with their status quo capabilities in terms of achieving their operational and strategic objectives. Terrorist innovation decisions can thus be expected to reflect the same pattern of problem solving observed with respect to states and other political collectives, as well as the notion of performance gaps as a major driver of technological innovation more broadly.[30] Since most terrorist groups will seek to redress a perceived performance gap as efficiently as possible (in other words, maximize the 'bang for their buck'), under this basic proposition the decision to adopt new attack technologies or tactics can be expected to take on many of the standard rational choice characteristics, including the weighing of costs and benefits. The pure interpretation of this approach in the general diffusion literature maintains that the innovation that is perceived to supply the greatest benefit for the least cost will be adopted.[31]

Yet, the basic notion of efficiently addressing perceived performance gaps tells us little about how or from where such performance gaps (or the perceptions thereof) might arise. For this, it is necessary to examine those factors, both within and without the terrorist organization, that might lead terrorists either towards or away from the realization that innovation is necessary. At the outset, it should be recognized that terrorist organizations (and indeed organizations in general) rarely if ever operate with an ideal form of 'absolute pragmatism' – the impetus to adopt innovations is ultimately

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[29] Martha Crenshaw, 'The Logic of Terrorism: Terrorist Behavior as a Product of Strategic Choice', in Walter Reich (ed.), *Origins of Terrorism: Psychologies, Ideologies, Theologies, States of Mind* (Washington, D. C.: Woodrow Wilson Center Press, 1998), p. 481.
[30] The performance gap can be defined as the perceived divergence between a given actor's expectations and its current level of performance (Rogers (2003), p. 422 and Eric Abrahamson, 'Managerial Fads and Fashions: The Diffusion and Rejection of Innovations', *The Academy of Management Review*, 16:3 (1991), p. 592).
[31] David Strang and John Meyer, 'Institutional Conditions for Diffusion', *Theory and Society*, 22 (1993), p. 489.

subjective and can emerge wherever a need is perceived,[32] which immediately highlights the potential role played by cognitive and affect-based biases and other framing effects.[33] For example, in the general context of technical innovation, MacKenzie stresses that the inherent uncertainties attached to an adoption decision lead actors to rely on heuristics and 'satisficing' in choosing whether and how to innovate, which can introduce a range of non-rationalistic (from the point of view of formal decision theory) influences on the adoption decision, such as culture, personality, social relations, and national circumstances.[34]

Organizational Incentives for Adoption

Several of the reasons a terrorist group may seek to adopt a new technology or practice can be viewed as focused on the organization itself and its direct interaction with internal or external entities.[35] The first such incentive is the desire to *overcome countermeasures*. Both state adversaries and civilian populations targeted by terrorists attempt to adapt their defences in order to reduce the occurrence and severity of terrorist attacks, both in terms of physical damage and coercive impact. This ensures that a terrorist group's activities take place in a dynamic, antagonistic operational context akin to a strategic game. As a consequence, terrorist groups may pursue new weapons or tactics in order to thwart defensive countermeasures.[36] As Hoffman argues, terrorists' 'fundamental organizational imperative to act' forces them to respond to this behaviour by outside actors.[37] This results in a manifestation of the previously described 'offence-defence' co-evolutionary dynamic, which has occasionally led to a form of 'arms race' between terrorists and governments,[38] in what Hoffman elsewhere describes as a 'technology treadmill'.[39]

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[32] This can occur even when such a need is self-created, such as when it is based on a delusional goal. Conversely, a genuine need that goes unrecognized by decision-makers may not prompt a consideration of weapons adoption, at least not for some time.

[33] Marisa Reddy Pynchon and Randy Borum, 'Assessing Threats of Targeted Group Violence: Contributions from Social Psychology', *Behavioral Sciences and the Law* 17 (1999), p. 345.

[34] MacKenzie, pp. 51-53. I discuss several of these 'non-rational' factors below.

[35] Indeed, Jackson and Frelinger contend that, 'The specific characteristics of a group and its environment can significantly influence how it makes decisions regarding technologies' (Jackson and Frelinger, p.4).

[36] Jenkins (1986), pp. 777-778; Kenney (2008), p. 162.

[37] Hoffman (1997), p. 15.

[38] Examples abound, including the technical 'arms race' in explosive triggers between the PIRA and British government forces (Jackson et. al., *Aptitude for Destruction Vol. 2*, p. 99), the similar dynamic with respect to IEDs in the Iraqi insurgency (Forest, 'Introduction', pp. 21-22) and perhaps even the adoption by al-Qa'ida of box cutters on 11 September 2001 as a means of circumventing the introduction, since 1973, of metal detectors into American airports.

[39] Hoffman (2006), p. 252.

A second incentive involves *desensitization and other escalatory pressures.* As asymmetric purveyors of a technique of violent manipulation, terrorists as defined usually concern themselves with the publicity they receive from their attacks.[40] If the public or the media that disseminate information on terrorist activities become desensitized to the terrorists' violent actions, then from the terrorists' point of view, there is a danger of being marginalized. It is widely argued that an increasingly noisy global media environment, in which a given type of terrorist attack can become almost routine, creates pressure for terrorists to expand their operational objectives in what Schmid and de Graff refer to as a 'built-in escalation imperative'.[41] Utilizing a novel weapon or tactic (especially a particularly sophisticated or frightening one) may be one manifestation of such an escalation.

A third set of incentives can arise from *inter- or intra-organizational competition*. In circumstances where multiple political organizations (both violent and non-violent) acting against a common antagonist are vying for sympathy, support, and recruits, terrorists might pursue new weapons or tactics in an effort to distinguish themselves from potential or actual competitor groups.[42] As technological proficiency is celebrated to a large extent in modern globalized cultures, a terrorist organization may believe that adopting advanced weapons or tactics before others do so will enhance, or at least preserve, its status relative to competitors.[43] Similarly, if a competitor has already adopted a novel, high-profile weapon or tactic, even a well-resourced terrorist organization with strong support might feel compelled to follow suit for fear of losing its current standing in the dissident milieu.[44]

At the same time, internal rivalries or factionalization within a terrorist group might induce either incumbent leaders or challengers to push for adopting new weapons or tactics as a means of bolstering their own positions within the organization by appearing

[40] Gressang, pp. 88-89.
[41] Alex P. Schmid and Janny de Graaf, *Violence as Communication: Insurgent Terrorism and the Western News Media* (Beverly Hills, CA: Sage Publications, 1982), p. 172.
[42] Dolnik, pp. 173-179; Bloom, pp. 162-163; Sawyer (2010), *passim*.
[43] Cragin et al., p. 45.
[44] Bale hypothesizes that 'top-rung terrorist groups (such as al Qa'ida) have to keep pushing the envelope in terms of attacks to stay relevant and "on top"', which might not apply to less influential or more localized terrorists (Jeffrey Bale, 'Conceptual Background and Literature Extracts' in Gary Ackerman, et. al., p.54). This is akin to the neorealist argument for weapons diffusion amongst states described in Chapter 2.

to be forward-thinking and daring. More generally, elements of an organization can influence the adoption of an innovation when internal rivalries between organizational factions or individuals within organizations push for or against the adoption of innovations irrespective of their actual relative advantage to the adopting organization. The possible reasons for opposing or embracing an innovation might thus include strengthening the faction's power base, mounting a challenge to another faction, gaining favour with the leadership, or any of a variety of other internal power plays.

It should be noted that the presence of any of the above three types of incentives does not necessarily drive a terrorist group to adopt radically new weapons or attack tactics. Countermeasures can be circumvented by target shifting or other minor tactical adjustments like increasing the number of attackers, while pressures stemming from competition or a perceived lack of publicity can result in alternative terrorist responses to gain attention, such as taking and brutally killing hostages. More generally, attack escalation does not guarantee new weapons or tactics adoption, or even innovation of any type by terrorists.[45] At the same time, even other avenues of attack expansion (such as drastically increasing the body count or attacking a prominent but well-defended target) might in turn necessitate the adoption of new weapons or tactics, thus providing an indirect instrumental motivation for turning to new technologies of lethality.

Furthermore, some violent non-state actors may be relatively unconcerned with political considerations, such as maintaining the support of terrestrial constituencies, and are instead oriented purely towards murder and mayhem as ends in and of themselves; yet, their decisions might still be rational within their frame of reference.[46] For such (relatively rare) nihilists, adoption decisions might be as simple as the most destructive means and methods that they can utilize within their resource constraints and perceived window for action.

Yet, the behaviour of both these actors and terrorists proper can also be affected by a variety of cognitive, emotional, cultural and other 'expressive' factors[47] that operate

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[45] See Palfy, p.91 for similar notions.
[46] Gressang, p. 96.
[47] One example of an expressive motivational factor is personal glorification, as described by Borowitz (Albert Borowitz, *Terrorism for Self-Glorification: The Herostratos Syndrome* (Kent, OH: Kent State University, 2005)). For other examples, including historical prejudice, limbic conditioning processes, and in-group maladaptations, see Kumar Ramakrishna, 'The Making of the Jemaah Islamiyah Terrorist' in Forest (2006), p. 250.

either consciously or unconsciously, and are often responsible for different tactical decisions of terrorist organizations within the same ideological milieu.[48] An important way in which such factors can impact tactical selection and adoption is through a non-strategic affinity for particular tactics or technologies, or for the process of innovation more broadly. Such predilection is often manifested in a desire to be on the 'cutting edge'.[49] This can be rooted in the organization's ideological doctrines,[50] but can also emerge from the idiosyncrasies of its leaders or key operational decision-makers, whether these reflect personal delusions or ego-driven desires to be regarded as a terrorist 'mastermind'.

There are several prominent examples of this dynamic. Besides the aforementioned Shoko Asahara's fascination with exotic weapons, another example is the almost metaphysical regard displayed by late nineteenth century radicals towards dynamite as a 'scientific' force for change.[51] Furthermore, Ahmad Jibril, the founder of the PFLP-GC, regarded himself as something of an inventor and wanted his organization to be the technical vanguard among terrorists,[52] while two decades later Ramzi Yousef similarly sought personal prestige in his creativity with explosives.

Environmental Incentives for Adoption

Although most motivational factors represent to some degree a confluence of forces both internal and external to the organization, certain changes that occur mainly in the terrorist organization's broader external environment (rather than acting directly on the organization) can fundamentally alter the decision calculus and precipitate or obstruct the desire to adopt an innovation.

The first of these involves changes that *decrease the costs* of adopting an innovation. Whereas previously the costs may have outweighed the benefits, a decrease in costs can

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[48] Bale, p.29.
[49] Dolnik found this factor to be relevant in each of the four case studies of innovation he conducted, declaring it to be 'the strongest and most universal pre-indicator of the propensity of a terrorist group to innovate' (Dolnik, pp. 156, 158, and 175).
[50] This is based on the notion that '[i]deology provides a motive – and possibly a formula – for action' (Drake, p. 16).
[51] Ronfeldt and Sater, pp. 2, 11.
[52] Dolnik, p. 94. In fact Dolnik found this element important in each of the four case studies of innovation he conducted.

rebalance a terrorist group's strategic calculations in favour of adoption. As discussed in Chapter 1, a central focus of this study involves one avenue by which costs might decrease, namely that technological advances in the broader society can make the acquisition of a particular lethal capability easier or cheaper to acquire, thus encouraging the adoption of a new weapon or tactic. Several examples of how costs might be lowered by emerging technologies were provided in the introduction, but an obvious historical case in the context of terrorism is the Irish Fenians' enthusiastic embrace of dynamite, which allowed them to create extensive damage with safer, more concealable and more portable packages, as compared with large barrels of gunpowder. They apparently regarded the invention of dynamite as a 'gift of science'.[53] This incentive falls under the more general phenomenon, described in Chapter 2, of invention acting as 'the mother of necessity'.

An important corollary to this concerns technologies or techniques that exhibit economies of scale. As the level of adoption increases, especially in the broader commercial sector, the acquisition costs to the terrorist group of such products or processes might fall.[54] Here, again, it is more the commercialization and mass production of new technologies, rather than functional characteristics of the technologies themselves, that lead to lower costs.

In addition to an actual change in the technological landscape, serendipity can play a role – the opportunistic or accidental acquisition of specialized skills or weapons materials can reconfigure the cost-benefit equation and prompt a terrorist group to seriously consider adopting a particular weapon or technique for the first time.[55]

The second environmental factor that might affect terrorist adoption decisions is *security pressures*, although the literature is split on how this factor might operate. On the one hand, scholars assert that periods of increased action and success by security forces can stimulate innovation on the part of terrorist groups as they struggle desperately to survive in a pressure cooker of counterterrorist activity.[56] On the other

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[53] Ronfeldt and Sater, p.14 ftn. 23. Also, Wilkinson, p. 2.
[54] Sawyer (2012), p. 18.
[55] Nancy Hayden, 'Terrifying Landscapes: Understanding Motivations of Non-State Actors to Acquire and/or Use Weapons of Mass Destruction' in Ranstorp and Normark, p. 167.
[56] Jackson et. al., *Aptitude for Destruction Vol. 1*, p. 15.

hand, there are indications that when experienced[57] terrorist organizations feel secure, with a safe haven[58] and/or a surfeit of resources,[59] they can investigate and possibly adopt new weapons or tactics as a strategic hedge against a future time when circumstances change, and their existing arsenal, despite being currently effective, becomes unable to fulfil their operational objectives.[60] The latitude to undertake this kind of exploratory weapons development is akin to successful companies engaging in speculative R&D in order to diversify and strengthen their portfolio in the long term. After conducting several case studies, Cragin, et. al. found some empirical support for both of these viewpoints.[61]

A third environmental incentive to adopt is one that has been much studied in the broader innovation diffusion literature, namely *emulation of other actors*. The uncertainty associated with attempting to adopt a new weapon or tactic can be reduced considerably if a terrorist learns that the weapon, tactic and related technologies have been developed or adopted and successfully and reliably used by another actor, even if it is another type of actor.[62] This might in turn lead to a cascade of adoptions among terrorist organizations and imitative diffusion thus forms an integral part of the terrorist innovation story. Salient concepts related to this dynamic include homophily, change agents and the notion of innovation momentum.

It has been argued that the more actors in a social system are alike (a property known as *homophily*), either structurally or culturally, the more likely adoption of an innovation becomes.[63] This tendency might arise as a result of increased trust – brought about by a common language, set of norms, and so forth – either in the initial user's experience or in its adequacy to serve as a model. However, homophily is by no means a necessary condition – cases of weapons or tactical emulation have occurred across quite disparate

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[57] Jackson and Frelinger, p. 25.
[58] Jackson, et. al., *Aptitude for Destruction Vol. 1*, p. 43.
[59] For example, the availability of copious financial resources has been identified as a major determinant in the FARC's ability to experiment with the development of complex weapons systems such as long-range mortars and anti-aircraft rockets (Forest, pp. 15-18).
[60] Jackson and Frelinger (pp. 27-28) discuss technology strategies, with groups being faced with the decision to invest in a variety of technologies in order to take advantage of attack opportunities that present themselves, versus maintaining a narrow arsenal. They posit that groups that do not pursue a variety of weapons will seek a smaller number of versatile weapons that are 'good enough' to exploit most opportunities.
[61] Cragin, et. al., p. 98.
[62] This is related to the concepts of fads and fashions that have been articulated in the business literature (see Abrahamson, *passim*).
[63] Strang and Meyer, p. 490.

terrorist organizations and even across ideological milieus, such as the discovery that some of the (often imperfect) recipes for extracting ricin found in al-Qa`ida manuals appear to be word-for-word translations of instructions published in underground right-wing literature in the United States.[64]

In almost all social domains, outside actors often attempt to influence, if not indeed drive, the adoption process, and terrorist adoptions are likely no different. *Opinion leaders* are members of the system itself who are able – generally by a combination of reputation and demonstration – to influence other members towards or away from adopting an innovation. Opinion leaders are often situated at the hub of a social network and there is some indication that larger, more successful and better resourced organizations are more likely to serve as models and thus have greater success as opinion leaders, should they so desire.[65] At lower organizational levels, 'invisible colleges' can form among technical experts across different groups,[66] which in the terrorism context might serve as conduits for raising awareness and encouraging adoption of new technologies and techniques of lethality between terrorist 'colleagues' in different organizations. Indeed, networks have been shown to have a significant and large impact on terrorist organizations' decisions as to whether to pursue CBRN weapons.[67]

Change agents are actors from outside a defined social domain who seek to encourage diffusion of innovations. As noted in the previous chapter, at the level of states, civilian producers of weapons have been known to fairly frequently 'push' new weapons systems onto military organizations. Analogues in the terrorism domain might include arms dealers, other transnational criminal organizations, or state sponsors that encourage the adoption of certain weapons or tactics for their own pecuniary or political purposes. It should be noted that change agents and opinion leaders can encourage adoption not only by demonstrating or declaring a weapon or technique's usefulness,

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[64] See Chapter 1, ftn. 35.
[65] See John Hagel, John Brown and Lang Davison, 'Shaping Strategy in a World of Constant Disruption', *Harvard Business Review,* 85:10 (October 2008), p. 88. Assuming that this observation remains relevant in the terrorist context, it is little surprise then that the attack methods and weapons of groups like Hizb'allah and al-Qa'ida have been adopted by a variety of other terrorist groups.
[66] Derek J. De Solla Price and Donald Deb Beaver, 'Collaboration in an Invisible College', *American Psychologist,* 21:11 (1966), pp. 1011-1018.
[67] Gary Ackerman, Victor Asal and Karl R. Rethemeyer, 'Toxic Connections: Terrorist Organizational Factors and the Pursuit of Unconventional Weapons', *Studies in Conflict and Terrorism*, 35:3 (2012), *passim*.

but also its legitimacy – ideologically or morally – in the armed struggle.

General diffusion research has repeatedly shown that spatial proximity between two actors enhances interaction and mutual influence.[68] One such study cited by Strang and Soule mapped radical ideology in Chile as spreading from mining communities to nearby agricultural communities,[69] while Jared Diamond stresses geographical proximity as a major factor in disseminating agricultural and other innovations, which according to this argument tended to spread more quickly across the East-West axis than the North-South axis (where climate and natural barriers hampered interaction).[70] This may also hold for terrorist groups or cells that operate in close spatial proximity to one another.

An important issue to consider in connection with emulating other actors is the *momentum of innovation* and the possibility of a self-fulfilling prophecy arising. General theorists of technology have described how diffusion often experiences increasing returns to scale,[71] which can encourage feedback loops of more and more adoption (whether self-initiated or through the efforts of change agents and opinion leaders). Even when this is not the case, if one or more actors adopt a new technology or tactic for purely idiosyncratic reasons, other potential adopters might misperceive this adoption decision and believe that adoption by others signifies that the technology or tactic is advantageous. If they in turn adopt the technology or tactic, this might spur more bandwagon-style adoptions, possibly leading to a non-linear adoption cascade reminiscent of the apocryphal onlookers of the Emperor who has no clothes. In this way, even a weapon, tactic or other technology that is sub-optimal with respect to almost all other features might serendipitously become 'locked' into widespread usage by terrorists. As Donald MacKenzie has observed, 'Technologies … may be best because they have triumphed, rather than triumphing because they are best'.[72]

This is linked to possibly the most ubiquitous and robust finding in all of innovation

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[68] Strang and Soule, p. 275; L. A. Brown, *Innovation Diffusion: A New Perspective* (New York: Methuen, 1981).
[69] J. Petras and M. Zeitlin, 'Miners and Agrarian Radicalism', *American Sociological Review,* 32 (1967), p. 578.
[70] Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W. W. Norton & Co., 1999).
[71] Arthur, p. 2.
[72] MacKenzie, p. 7.

studies, namely, that in the vast majority of cases the cumulative number of adopters of an innovation when plotted over time yields an 'S'-shaped curve, with a slow initial adoption rate, followed by a rapid take-off in adoptions and, finally, a slowdown as late adopters gradually take up the innovation.[73] This finding reflects the pattern of innovation diffusion in a surprisingly wide variety of contexts, irrespective of the nature of the innovation or the identity of the individual adopters.[74] While it has never been tested in the terrorism context, there is thus every reason to expect it to apply to terrorist adoption as well. What the S-curve demonstrates is that the number of prior adopters can have a large impact on the pace and number of future adopters, something that has already been mentioned. In particular, it shows that innovations can have extended periods of latency followed by a rapid acceleration in adoptions.[75] Indeed, Rogers argues that the portion of the diffusion curve representing points between 10 and 20 percent adoption is crucial in that after this point 'it is often impossible to stop the further diffusion of a new idea'.[76] Thus, even when conducting analysis from the viewpoint of a single terrorist organization's adoption decision or efforts, it is important to note where in the adoption macro-cycle the innovation is. In other words, one must pay close attention to such factors as the maturity and commercialization of the innovation, as well as the number of prior adopters. As David Landes has observed, 'Each innovation seems to have a life span of its own, comprising periods of tentative youth, vigorous maturity, and declining old age'.[77]

A parting remark is merited in regards to emulation as a driver of innovation. In the general innovation literature, there is the hypothesis that the early stages of diffusion (i.e. with few prior adopters) predominantly reflect rational cost-benefit adoption decisions, while such decisions in later stages are determined more by faddish imitative

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[73] Rogers (2003), pp. 272-274; Bryce Ryan, 'A Study in Technological Diffusion', *Rural Sociology*, 13 (1948); Robert Hamblin, R. Jacobson and J. Miller, *A Mathematical Theory of Social Change* (New York, NY: Wiley, 1973); Vijay Majahan and Robert A. Peterson, *Models for Innovation Diffusion* (Newbury Park, CA: Sage Publications, Inc., 1985), p.8.

[74] This has led to the development of a range of mathematical models (Majahan and Peterson, *passim*) designed to predict the future diffusion course and potential of an innovation in a given system (usually long-term sales of consumer goods in a given market), the more sophisticated of which include components representing external influences like change agents (Thomas W. Valente, 'Diffusion of Innovation and Policy Decision-Making', *Journal of Communication*, 43:1 (March 1993), p.30) as well as the number of prior adopters in the system. Yet, such models are often limited by stringent sets of assumptions and their ability to describe only the overall rate of adoption (Strang and Macy, 'In Search of Excellence', p.148).

[75] Strang and Soule, p.278.

[76] Rogers (2003), p. 274.

[77] David Landes, *The Unbound Prometheus* (Cambridge: Cambridge University Press, 2003), p. 3.

dynamics, even when this represents adoption of inefficient innovations.[78] In situations where adoption decisions are driven by their own momentum, DiMaggio and Powell believe that the primary element of the decision becomes which actor to emulate rather than which innovation to adopt. [79]

A fourth adoption factor that exists apart from the terrorist organization relates to the *nature of the innovation* itself. The physical, logistical, and other characteristics of the weapon or tactic under consideration can be expected to influence the probability of adoption by terrorists, based on several findings from the broader innovation diffusion literature. It has been argued that, all else being equal, innovations perceived to have greater trialability and observability, as well as less complexity than others are more likely to be adopted.[80] There are several additional attributes specific to weapons that are discussed in a separate section below.

Adoption Decision Modifiers

In many cases, actors (including terrorists) will reject innovations in spite of clear strategic, tactical, political, ideological or psychological benefits and low apparent costs, or conversely, attempt to adopt innovations despite seemingly insurmountable obstacles.[81] This implies that other factors condition the decision to adopt innovations, factors that scholars have identified as being rooted in the inherently social and psychological nature of the adoption process. Although not acting as drivers of adoption themselves, there may thus be several features that can retard, facilitate or otherwise shape the decision to adopt a new weapon or tactic, on occasion even overriding the core rational cost-benefit calculus of weapons adoption described above.

At the outset, terrorist organizations must invariably contend with the conservative

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[78] Abrahamson, pp. 605-606.
[79] Paul J. DiMaggio and Walter W. Powell, 'The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields', *American Sociological Review*, 48 (1983), pp. 147-160.
[80] *Trialability* represents the degree to which the innovation can be experimented with on a trial basis. *Observability* is the ease with which the results of the innovation and its prior adoption are observable to others (Rogers (2003), pp. 15-17).
[81] Illustrative examples of these in the case of terrorism can be found in the case studies in the following sections. The archetypal and perhaps most widely-cited case in the general innovation adoption literature is the diffusion of the prophylaxis for scurvy, which even after James Lind, a British naval officer wrote a treatise in which he identified the importance of citrus fruit, was not implemented by the Royal Navy for several decades (James Lind, *A Treatise on the Scurvy* (London: A. Millar, 1753)).

operational tendencies – detailed in the introductory chapter – that combine to produce an *organizational inertia* that usually takes the form of a reticence to adopt new weapons or tactics. This stands as an *a priori* impediment to innovation that must be overcome and can be especially prevalent among self-appointed guardians of the *status quo* whose status within the organization might diminish if extant practices are displaced by novel means of combat.[82]

Then there is the most obvious delimiter of an adoption decision, i.e., that the adopter must perceive the technology to be within its technical abilities and resources, or at least within its expected capacity to acquire these.[83] Terrorist weapons and tactics adoption are no exception, and are thus constrained by issues of *practical feasibility*. The FARC, for example, was thus able to innovate when it came to mortars and rockets, since it could easily afford to pay the IRA for instructional assistance. [84] In addition, economists have argued that the innovation must, in most cases, also be economically feasible, that is, at least as efficient as existing ways of operating.[85]

However, the wider diffusion literature suggests that even *prima facie* technical, financial and economic feasibility may be insufficient because the potential adopter can shy away from secondary obstacles and costs beyond the innovation itself, such as when an adoption requires an expensive restructuring of an entire organization and its institutional practices.[86] Moreover, in the case of terrorist innovation, initial empirical results seem to suggest that while a minimum level of resources (and presumably technical skills) are necessary, the possession of copious resources by no means guarantees that adoption will be pursued.[87]

In addition to practical feasibility, there is the issue of *ideological and cultural*

[82] While the existing terrorism literature does not specifically describe instances of this internal opposition to new technologies occurring within terrorist groups, the phenomenon is extensively detailed in the general technology adoption literature and, as will be shown in the case study of the PIRA, has been observed in terrorist groups as well.
[83] Clayton M. Christensen, Erik A. Roth and Scott D. Anthony, *Seeing What's Next* (Boston: Harvard Business School Press, 2004), p. 21. For the particular difficulties presented by CBRN weapons in a terrorism context, see Bale and Ackerman, 'Profiling the WMD Terrorism Threat', *passim*.
[84] Román D. Ortiz, 'Renew to Last: Innovation and Strategy of the Revolutionary Armed Forces of. Colombia (FARC)', in Forest (2006), p. 215.
[85] Mokyr (1990), pp. 291-292.
[86] Arthur, 139.
[87] Dolnik, based on his case studies, concludes that the relationship between resources and terrorist innovation is relevant but is not necessarily unconditional (p. 164).

compatibility. As noted above, an ideological attachment to certain weapons or tactics, or a culture that embraces innovation can prod decision-makers in the direction of adopting a new weapon or tactic, but the converse is also true.[88] At the very least, for adoption to be pursued the use of the new weapon or tactic must not be anathema to deeply held cultural values or the worldview of the terrorist.[89] As was often the case with respect to the historic weapons adoption described in the previous chapter, in certain cases it may not be the weapon or tactic itself, but the ideas, practices and structural changes its adoption might engender, that are resisted by the group's ideologues. Similar arguments apply with respect to attitudes towards innovation in general.[90] So, while an ideology or an organizational or national culture that embraces innovation can facilitate a positive adoption decision, ultra-conservative belief systems that decry innovation of any kind are far less likely to approve of adopting a new, untried weapons system or attack technique. However, while ideology has been characterized in the literature as an important determinant of terrorists' decision-making in general, and of their adoption of weapons or tactics in particular, it is not always paramount in adoption decisions and can be overridden by other concerns[91] or even adapted to permit the adoption.[92]

Several scholars have asserted that the most likely terrorist organizations to innovate are those that have a high *tolerance for risk*, i.e. are willing to tolerate some degree of operational failure.[93] This reflects the broader understanding that any innovation requires deviating from the *status quo* to embrace an uncertain alternative, and will thus be facilitated by a higher risk threshold within the organization or the broader culture in which the organization is situated.[94] The amount of risk a group is willing to tolerate is, however, dynamic and can alter according to changes in the circumstances or

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[88] Hoffman (1997), pp. 171-172.
[89] Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002), p. 249. In certain cases, it can therefore even be advantageous for a terrorist group to have an ill-defined or amorphous ideology. Ortiz, for example, identifies the FARC's capacity for operational innovation with the organization's ideological flexibility (Ortiz, p. 209).
[90] Mokyr (2002), p. 241.
[91] Cragin et al., pp. xv, 44.
[92] The decision by the traditionally paternalistic Islamist terrorists to allow female suicide bombers is one example of how practical exigencies can lead to a rethinking of long-held beliefs. Jenkins (Jenkins (2008), p. 29) depicts a contemporary 'democratization of extremism' where it is possible to 'in a sense shop for belief systems', which suggests that even an ideological proscription against a particular weapon might not be absolute if certain adherents desire the weapon badly enough.
[93] Jackson (2001), p. 203; Trujillo and Jackson, p. 61; Dolnik, p. 167.
[94] Mokyr (2002), p. 157.

environment.[95]

This brings the discussion to the impact of *organizational structure* on adoption decisions. The structure of a terrorist organization – whether a cohesive, hierarchical organization like Hizb'allah or a more diffuse network like the broader al-Qa'ida movement – often has a large impact on its behaviour, so it might be expected that this extends to the decision about whether or not to adopt an innovation. First, having a centralized leadership within a strict hierarchy means that, providing the leadership is aware of an innovation and amenable to it, naysayers in the remaining parts of the organization can be overruled; in many cases a leader can act with single purpose to drive the organizational adoption of a new weapon or tactic. Terrorist leaders from Shoko Asahara of Aum Shinrikyo to Hassan Nasrallah of Hizb'allah have taken their organizations along in adopting non-traditional weapons and tactics. Perhaps this is why Dolnik opines that '...radical innovation is virtually always a product of a top-down approach'.[96] Moreover, terrorist outfits modelled hierarchically after military organizations often tend to specialize functionally, in other words 'bureaucratize', making it more likely that a specific organ will emerge that focuses on research and development, thus generating a constituency for innovation.

At the same time, these very dynamics can present a double-edged sword for innovation. For if a leader or bureaucratic constituency in a rigid organizational structure is risk averse or wedded to the status quo, there is little scope for innovation to develop organically. In hierarchical terrorist organizations, therefore, the decision to innovate is very much dependent on the attitudes towards innovation espoused by leaders or other key gatekeepers of the hierarchy, either in general or with respect to a specific weapon or tactic.

Decentralized terrorist networks, while often smaller and less well-resourced at the operational level than their hierarchical cousins, do possess some strengths when it comes to recognizing and pursuing innovations. Decentralized networks are generally more likely to have the freedom to experiment – for every cell with a leader who

[95] Indeed, Trujillo and Jackson maintain that 'Risk tolerance is a function of the group's ideology and the external environment, as well as other variables' (Trujillo and Jackson, p. 61) only some of which are likely to be relatively stable over time.
[96] Dolnik, p. 178. Of course, as previously mentioned, leadership in any organization is never absolute, and there are inevitably opportunities for functionaries to influence or frustrate leadership decisions.

disdains innovation, there may be another with a leader who embraces it. Those innovations that prove successful can then percolate to other elements of the network, especially given the Internet and other modern communications tools that allow disparate groups to maintain contact and share tactics. This allows for a more organic approach to innovation with little risk to the resources or the prospects of the overall network.

More amorphous terrorists do face several important constraints on their ability to embrace new weapons and tactics, however. One important weakness of decentralized organizations is that disparate members who interact sporadically and remotely may find it difficult 'to engage in a deliberative concerted decision-making process',[97] and thus may not be collectively cognizant of the costs or benefits of an innovation for the organization as a whole. While modern communications technologies might make decentralized awareness and decision-making feasible, they do not necessarily make it as seamless as operations under spatial proximity, which ensure direct interaction and influence between actors.

Therefore, each type of terrorist organizational structure affords both advantages and disadvantages for a positive decision to innovate and much depends on the specific attributes of the terrorist network or hierarchy.

Last, it is possible for innovation (and hence new weapons or tactics adoption) to occur without any discernible motivating factors. One might find this occurring in overly bureaucratic organizations where innovation has become so institutionalized or routine, that it occurs without a conscious decision. While probably rare among terrorist organizations in practice, it is not unheard of. Jackson, et. al., for example, note that in some cases the IRA altered the construction of explosive devices with no clear reason or obvious improvement in performance.[98]

Factors Influencing Adoption Success

[97] Sawyer (2012), p. 13; Jackson, et al. *Aptitude for Destruction Vol. 1*, p. 39.
[98] Jackson, 'The Provisional Irish Republican Army' in Jackson et al., *Aptitude for Destruction Vol. 2*, p. 105, ftn. 20. Oppenheimer noted that the bombers would often get ahead of themselves in innovating new designs before effective countermeasures could be developed, which sometimes was actually counterproductive (A.R. Oppenheimer, *IRA, The Bombs and the Bullets: A History of Deadly Ingenuity* (Dublin: Irish Academic Press, 2009), p. 200).

Following the decision by a terrorist group to pursue the adoption of a new weapon or tactic, in many respects the most consequential question then becomes whether or not it will succeed in doing so. As with the adoption decision, a basic logic predominates, one that is associated with any acquisition endeavour. It goes almost without saying, therefore, that the *sine qua non* for an adoption attempt to succeed is that the underlying principle, practice or technology must be practically feasible within the abilities and resources of the erstwhile adopter and that the would-be innovator is capable – within an appropriate period of time – of marshalling these abilities and resources towards the goal of adoption.

Yet, also as with the adoption decision process, these basic requirements for the success of innovation adoptions – and even more specifically terrorist adoptions of new weapons or tactics – are shaped by a host of contingent organizational and environmental factors that ultimately facilitate or retard any adoption efforts. The following are the main influences on the outcome of adoption attempts highlighted by the literature, together with how these might manifest in the terrorism context.

The first major determinant of adoption success is *appropriately transferring knowledge* about how to produce and use an innovation. There is at least some possibility of compensating for shortfalls in most other aspects of adoption – for example an organization may be able to work around resource deficits through improvisation or theft – but it is far more difficult to successfully adopt an innovation without the proper transfer of knowledge about the innovation to the adopting organization. This topic has been discussed at length elsewhere,[99] but its centrality warrants a description of its most important features.

The core concept in innovation knowledge transfer is that of differential knowledge requirements, to which a suitable introduction can be made by a discussion of tacit versus explicit knowledge. The basic notion is that in any transfer of knowledge about a practice or technology, there are at least some elements that cannot be captured in

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[99] Kenney (2008), passim, esp. p. 4; Michael Kenney, ' "Dumb" Yet Deadly: Local Knowledge and Poor Tradecraft Among Islamist Militants in Britain and Spain', *Studies in Conflict & Terrorism*, 33:10 (2010); Jackson et. al., *Aptitude for Destruction, Vols. 1 and 2*. Cf. Arthur's 'deep craft' (Arthur, pp.159-160).

easily-transmissible media, such as manuals, textbooks or Internet sites.[100] Such tacit knowledge elements, usually related to the 'how-to' skills associated with an innovation, often need to be transferred from person to person in a hands-on manner usually akin to some form of apprenticeship – they are essentially recreated each time they are transferred.[101] Moreover, unlike explicit knowledge that can be preserved in books and on Internet forums, tacit knowledge can much more easily be lost,[102] which might pose particular problems for terrorists who are at risk of losing the human repositories of its tacit knowledge (for example, bomb-makers) to arrest, accident or assassination. Several scholars appear to argue strongly that successful innovation requires proficiency in or transfer of both tacit and explicit elements. In the particular context of the transfer of new weapons and tactics to and across terrorist organizations, Jackson contends that the requirement to transfer tacit knowledge, which is generally less accessible, can complicate or derail successful adoption. These considerations, he suggests, are present even in the case of 'off-the-shelf' weapons, which usually still require tacit expertise to utilize effectively.[103]

Michael Kenney has refined this notion further by distinguishing between *techne* and *mētis*. *Techne* relates to abstract, universally-applicable technical knowledge that underpins specific applications, whereas *mētis* represents to a large extent the instantiation of *techne* in a particular real-world context. In addition, *mētis* embodies the 'practical skills and acquired intelligence' that results from partaking in the activity itself[104] and is also associated with a form of 'cunning', the ability to improvise and develop workarounds when confronted with unforeseen, practical obstacles. So, while *techne*, for instance, might take the form of a bomb-making recipe, *mētis* would then be the practical know-how possessed by a competent bomb-maker that allows him to transform the recipe into a working device, including the local awareness to figure out which of the materials that he has access to can substitute in the recipe for those he does not, as well as the ability to acquire and work with these materials without being

[100] Cowan and Foray argue that tacit knowledge is a complement to, rather than a substitute for, explicit knowledge, in that even codebooks and manuals require (tacit) shared understanding in order to be correctly interpreted (Robin Cowan and Dominique Foray, 'The Economics of Codification and the Diffusion of Knowledge', *Industrial and Corporate Change*, 6:3 (1997), pp. 595-622).
[101] MacKenzie, pp. 216, 235.
[102] MacKenzie, p. 216.
[103] Jackson (2001), pp. 187-188, 197.
[104] Kenney (2010), p. 912; Kenney (2008), p. 4.

discovered by authorities.[105]

Whereas explicit and tacit knowledge relate primarily to the tangibility and codifiability of the knowledge in question, *techne* and *mētis* focus more on the universality versus the contextual particularity of that knowledge.[106] Sawyer supports Kenney's formulation and argues that, in the terrorism context at least, assessing knowledge transfer from the perspective of *techne* and *mētis* may be more germane because terrorists often need to transfer knowledge and skills, not only across geographic regions, but also between functional disciplines. In these circumstances, the practical application of technical knowledge in a particular context is paramount, especially when an organization is operating in a hostile counterterrorism environment.[107]

There are, indeed, several examples of terrorists attempting to adopt new weapons or tactics where the lack of the requisite *techne* and *mētis* has been responsible for the failure of these efforts. From the often disastrously mistargeted bombs used by the anarchist acolytes of Luigi Galleani in their campaign between 1914 and 1920[108] to Aum Shinrikyo's failure to develop or disseminate pathogenic strains of biological agents despite copious resources and technical skills,[109] even when terrorists possess the technical background, their lack of *mētis* can stifle success. This is not to say that *techne* and *mētis* can be transferred only in person. British neo-Nazi David Copeland, for instance, successfully detonated three nail bombs in 1999 and reportedly was self-taught using instructions found on the Internet.[110]

The prospects for knowledge transfer to occur are tied up in an organization's capacity to interpret, incorporate and institutionalize new information from outside the organization, which is asserted to become easier the greater the similarity between the

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105 Michael Kenney, personal correspondence (11 March 2013).
106 It has been argued that *mētis* may indeed be 'a necessary component for transforming *techne* into context-specific explicit knowledge' (Sawyer, 'Knowledge of Weapons and Weapons Technologies' in Ackerman and Sawyer, p. 6).
107 Ibid., p. 6.
108 Ann Larabee, 'A Brief History of Terrorism in the United States' in Clarke (ed.), p. 33.
109 Milton Leitenberg, 'Aum Shinrikyo's Efforts to Produce Biological Weapons: A Case Study in the Serial Propagation of Misinformation', *Terrorism and Political Violence* 11:4 (Winter 1999); John Parachini, 'Aum Shinrikyo' in Jackson et. al., *Aptitude for Destruction, Vol. 2*, p.19.
110 'The Nailbomber', *BBC Panorama* (30 June 2000). Transcript accessed at http://news.bbc.co.uk/hi/english/static/audio_video/programmes/panorama/transcripts/transcript_30_06_00.txt on 11 March 2013.

new knowledge and that already possessed by the organization.[111] Institutionalization of knowledge is important if this knowledge is to be characterized as robust and not dependent on a single individual or handful of individuals. Otherwise, these individuals become key nodes and the continued adoptive capacity of the organization is susceptible to removal of these nodes, a constant danger in the terrorists' world.[112] The degree of institutionalization of knowledge is presumably correlated to some degree with the depth of the talent pool with sufficient *techne* and *mētis* for a particular tactic or weapon, and the deeper the pool, the more robust a terrorist organization is likely to be in the face of numerous external threats.

A second key component of the adoption outcome, one that is both obvious and crucial, is the *nature of the technology or practice* under consideration,[113] since this determines the threshold that the adopter's resources and abilities must meet. In almost all cases, the more complex[114] and resource-intensive the technology or practice is to acquire or produce, the more difficult it becomes for the group to achieve adoption success. This has several corollaries. First, it can be expected that, all else being equal, technologies and practices with lower acquisition costs and with lower knowledge requirements (in terms of the *techne* and *mētis* required to produce and use them) will have a greater chance of being adopted successfully. Second, technologies and practices that are mature (late in their life-cycle) will likely be easier to adopt, since much of the trial and error inherent in the adoption process will have already been completed by prior adopters and thus more is likely to be known about the technologies themselves and the most effective ways to acquire or produce them. Similarly, a mature technology is more likely to spur the creation of supply markets, at least for its component parts. Terrorists are also likely to benefit in terms of adoption success from technologies that are commercially available (even if not intended to be used for violent purposes), which makes both the underlying knowledge base and the physical components of the

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[111] Bronwyn H. Hall and Beethika Khan, *Adoption of New Technology* (Cambridge, MA: National Bureau of Economic Research, 2003); Shanti Gopalakrishnan and Paul Bierly, 'Analyzing Innovation Adoption Using a Knowledge-Based Approach', *Journal of Engineering and Technology Management*, 18 (2001), pp. 107-130; and David Robinson, Grant Savage, and Kim Campbell, 'Organizational Learning, Diffusion of Innovation, and International Collaboration in Telemedicine', *Health Care Management Review*, 28:1 (2003), all cited in Jackson, et. al., *Aptitude for Destruction Vol. 1*, p. 41.
[112] Jackson, et. al., refer to the PIRA's loss of their primary engineer in charge of its anti-aircraft missile system, which effectively curtailed its R&D program in that area (*Aptitude for Destruction Vol. 1*, p. 25), while Cragin, et. al., assert that the FARC succeeded in codifying and inculcating within its organization the technical lessons given them by the PIRA in the affair of the so-called 'Colombia Three' (p. 90).
[113] Dolnik, p. 172.
[114] Rogers (2003), p. 15.

technology more easily accessible.

Of particular relevance in this regard is the long-held recognition that innovation in a particular area of activity is often inextricably connected to (and sometimes dependent on) parallel technological or behavioural developments in related or constituent domains.[115] A recent case in point is the observation that tremendous leaps in computing power have enabled the practical, low-cost sequencing and manipulation of genomes, thus opening synthetic biology up to rapid commercialization.

Several of the attributes of the technology itself that can affect the adoption decision might have an even greater effect on the outcome of the process. In particular, Rogers argues that the greater the trialability of an innovation, its compatibility with the adopting entity and its observability, the more rapidly it is likely to be adopted.[116] The rate of adoption is also assumed to be at least partly a function of the success of prior attempts at adoption.

The third, and perhaps most obvious, major factor contributing to the success (or failure) of an adoption attempt is the level of *organizational resources*. In a small minority of cases, the adoption of a new weapon or tactic by a terrorist organization will require no additional physical resources over the status quo practice, such as when a group is bequeathed a new weapon by a patron or a tactical innovation involves decidedly inexpensive hardware (for example, the use of box cutters to commandeer an aircraft).[117] However, in the vast majority of instances, the adoption of an innovation will require the devotion of significant amounts of organizational resources for tasks such as transferring or developing the relevant *techne* and *mētis*, acquiring raw materials and equipment used to produce the innovation, integrating the innovation into existing operational schemas, maintaining security, and so forth.

Possessing a variety of resources in substantial amounts not only makes it more likely

[115] Landes, p.2; Mokyr (2002), p. xi. and Arthur, p.134.
[116] Rogers (2003), pp. 15-17. Indeed, Rogers argues that between 49% and 87% of the rate of adoption across innovations can be explained by relative advantage, the complexity of the innovation and these aspects of the innovation (p. 221).
[117] Even cases such as these almost always require an investment in time and skill development to train with the new weapon or technique and, of course, the inherent uncertainty with respect to embracing any innovation remains, which might demand additional attention from planners and leaders, a resource that is often in short supply in terrorist groups.

that the basic feasibility criterion will be met, but it can also facilitate innovation by allowing, for example, numerous people with different expertise to work on the innovation (thus bolstering network effects) or for extensive experimentation with different methods and materials, not to mention the ability to 'buy [one's] way out of technical difficulties'.[118] Significantly, ample resource reserves allow organizations the latitude to devote significant resources to the adoption process without short-changing other vital organizational functions. All else being equal, therefore, one can expect more successful innovation the more resources are expended in this direction. For example, Aum Shinrikyo's assets of between $20 million and $1 billion[119] enabled it to pursue chemical, biological and nuclear weapons programs simultaneously, and to purchase its way around at least some technical obstacles.[120] However, the Aum case also shows that even tremendous financial resources cannot always compensate for other organizational deficiencies, in that case the lack of suitably skilled and motivated personnel to work on their biological weapons efforts.

One factor that is argued to have some impact at the awareness and decision stages of the innovation adoption process, but whose effect is especially pronounced at the implementation stage, is *organizational structure*. The literature, however, is not consistent as to the effect of different structural attributes on the adoption outcome. Trujillo and Jackson cite research which suggests that 'more hierarchical organizations frequently learn less effectively, due in part to the loss of information as it is transmitted through and screened by the different organizational levels'.[121] At the same time, Jackson elsewhere maintains that a cellular group structure makes robust technology transfer by the entire network 'essentially impossible',[122] leaving the situation far from clear as to what type of terrorist organizational structure is advantageous for the successful adoption of innovation.[123]

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[118] Gavin Cameron, 'Multi-track Microproliferation: Lessons from Aum Shinrikyo and Al Qaida', *Studies in Conflict and Terrorism* 22:4 (November 1999), p. 296.
[119] Kaplan, p. 210.
[120] Jackson et. al., *Aptitude for Destruction, Vol.2*, p. 22.
[121] Trujillo and Jackson, p. 60, citing David Schweiger, Tugrul Atamer and Roland Calori, 'Transnational Project Teams and Networks: Making the Multinational Organization More Effective,' *Journal of World Business*, 38 (2003).
[122] Jackson (2001), p. 200.
[123] This ambivalence extends to the realm of general innovation, where Rogers, after surveying several hundred studies of organizational innovativeness, could not confirm previous assertions that low levels of centralization and formalization are associated with more successful innovation and suggests that this may be due to these variables having a positive effect on innovativeness in the initial stages of an innovation decision but a negative effect during the implementation stages, or vice versa (Rogers (2003), pp. 412-413).

One area where there is some degree of consensus is that larger organizations generally embrace innovations more rapidly.[124] However, whether group size is significant in its own right, or as a proxy for a host of other variables like the availability of personnel, sufficient resources or an existing knowledge base,[125] is still an open question. After all, being a large group is hardly necessary and even relatively small terrorist groups like Action Directe have succeeded in innovating tactically.[126]

Complicating purely structural characteristics is the effect of *intra-organizational authority relationships*, which can serve as both impediments to and facilitators of successful adoption. The ability of functionaries in an organization to influence leadership decisions whether to proceed with adopting an innovation or not has already been introduced during discussions of the adoption decision. Yet, after a decision has been made to proceed, such personnel can still subvert or expedite implementation. While there is little direct engagement with this issue in the terrorism literature, the wider diffusion literature maintains that even in those situations where internal constituencies lack the power to actively resist implementing an adoption, adoption efforts may be slowed down by an ingrained organizational routine originally developed to ensure continuity and stability.[127] Conversely, the influence of internal supporters can have a strong impact on the success of an innovation. In many cases, innovation is facilitated by the presence of internal organizational champions and a strong, supportive coalition in favour of either innovation in general or the particular innovation under consideration.[128]

Thus, although the balance of the existing argument appears tilted somewhat towards more centralized (although not necessarily hierarchical) organizations as being generally more successful in implementing adoption efforts, overall adoption outcomes are likely to be highly contingent on more specific contextual attributes. For example, a strong leader in a more centralized organization may be better able to focus the organization's attention and marshal its resources towards an adoption effort, but it is

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[124] Ibid., pp. 409-411.
[125] Jackson (2001, p. 202) seems to favour the latter explanation.
[126] Wilkinson, p. 5, describes the damage to computer systems perpetrated by Action Directe and its offshoot, the *Comite Liquidant ou Detoumant les Ordinateurs* (Clodo), beginning as early as 1980.
[127] Rogers (2003), p.150.
[128] Strang and Soule, p.270.

also at the implementation stage that subordinates who could not countermand the leader's positive adoption decision may have the greatest opportunity to frustrate their superior's designs. The presence or absence of such contingent factors as internal roadblocks may therefore have more of an effect on adoption success than broad structural characterizations.

Furthermore, among the many other strategies adopted by organizations and individuals to overcome structural and other organizational innovation barriers is the creation of a specialized bureaucratic organ specifically tasked with research and development. The institutionalization of such organizational entities is argued to facilitate successful adoption, made even more effective when these take the form of separate, semi-independent 'skunkworks' specifically designed to avoid bureaucratic inertia and vested interests.[129] Albeit rarely, these functional organs have appeared within terrorist groups, including Hizb'allah and the LTTE. Another purposive organizational change that can facilitate innovation is the use of specialized brokers to bridge various domains and seek out and nurture new technologies and practices.[130]

Moving away from factors unique to the terrorist organization, a variety of environmental factors is believed to affect adoption outcomes. Arguably the most valuable source of assistance in adopting new technologies or practices for a terrorist comes from *state patrons*. Although state sponsorship might be accompanied by a host of externalities, from a loss of autonomy to the unwanted attention of the state's enemies, there is little doubt that states can provide an invaluable boost to terrorist capabilities. From the direct provision of intact weapons systems that a terrorist organization could not hope to fashion on its own (for example, Iran's provision of Zelzal 2 missiles to Hizb'allah[131]) to assistance with logistics in the carrying out of attacks (again, Iranian assistance to Hizb'allah in the 1990s bombings in Argentina is a good example), the well-developed military and espionage apparatus of a state can significantly increase the chances of successful innovation adoption. Then there is the more indirect, yet often just as beneficial supply of financial resources or training,

[129] Rogers (2003), p.149.
[130] Hargadon, p.26.
[131] Bilal Saab, *Levantine Reset: A New U.S. Strategy for Lebanon* (Washington, DC: Saban Center for Midlle East Policy at the Brookings Institution, April 2010) and Anthony Cordesman, *Preliminary "Lessons" of the Israeli-Hezbollah War* (Washington, DC: Center for Strategic and International Studies, 2006), p. 17.

which, as discussed, are themselves major determinants of innovation success.[132] There are also those cases where a state does not actively support a terrorist organization, but merely passively allows the terrorists to operate in its territory unmolested, thus creating ‘breathing room’ where an organization can focus on adoption without the distractions of avoiding counterterrorist forces. It should be noted, however, that even in the most extreme cases of support, such as where a state sponsor bestows upon a terrorist organization an entire weapons system, adoption success is neither automatic nor guaranteed, since the terrorist organization still has to integrate the weapon into its operational and strategic processes, including command and control, training regimens, operational security and so forth.

Other actors in a terrorist group’s environment can also aid successful adoption, which brings the discussion to the topic of *networks of violent and criminal non-state actors*.[133] Several researchers decry the ‘myth of the lone genius’[134] and claim that, in general, communities of practice and social networks facilitate innovation.[135] A diversity of expertise and bringing in new blood periodically from across one’s connections has also been favourably described as helping to catalyse innovation. Cragin et. al. have described several cases where technology exchange occurred successfully across terrorist networks and between separate organizations, including Indonesian Jemaah Islamiyah providing the capability to field advanced IEDs to various Filipino militants, as well as the transfer of Katyusha rockets and suicide bombing techniques from Hizb’allah to Palestinian militants in Gaza and the West Bank.[136] Other violent or criminal groups such as illicit trafficking networks could play a similar role in different geographical contexts.

Not all networks will facilitate adoption, however. There are often a host of disincentives in place to confound the development of collaborative networks,

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[132] For several early examples of state sponsors assisting terrorist groups with new weapons and techniques, see G. Davidson Smith, ‘Sources of Terrorist Weaponry and Major Methods of Obtaining Weapons and Techniques’ in Wilkinson (ed.), pp. 125-126.
[133] This is distinct from, but overlaps, the previous discussion relating to change agents and opinion leaders.
[134] Hargadon, p.93.
[135] Hargadon, pp. ix, 60; Chesbrough, p. x; and Arthur, p.108.
[136] Cragin, et. al., pp. xiv, 48, 63.

especially across disciplines[137] and within hierarchies,[138] which could stymie or delay successful innovation. Moreover, organizational research suggests that merely having multiple interactions among organizations is not sufficient to ensure success, especially if the necessary forms of knowledge are not transferred properly.[139]

The important influence that the external environment can have on the success of terrorist innovation adoption can clearly be seen in the case of the FARC's innovations in the 1990s and early 2000s. To begin with, Colombia's industrialization made it easier for the FARC to acquire technically proficient personnel and raw materials. The organization's forays into illicit narcotics trafficking served to expand its clandestine networks and stock its coffers with large amounts of cash.[140] Perhaps most importantly, the FARC's association with the Provisional Irish Republican Army – as illustrated by the notorious case of the 'Colombia Three' – resulted in the direct transfer to the FARC of sophisticated Irish Republican Army operational capabilities, such as homemade mortars and remote detonation and launch capabilities.[141] Indeed, Ortiz declares that 'the success of insurgents upon introducing changes in their political and military conduct depended on their innovative skills for taking advantage of the ideas and resources offered by the strategic environment to develop solutions for the challenges faced by them.'[142]

Finally, an important component in a successful adoption outcome is often *learning and the will to succeed*. Adoption is rarely a one-shot event – initial failure can be followed up by subsequent success, especially if an organization applies a trial and error approach to adopting an innovation. Since an observed failure to adopt a new weapon or tactic may therefore merely signal an intermediate stage in a terrorist group's successful adoption rather than an outright inability to adopt, Jackson, et. al. justly appear to caution against inferring too much from apparently botched tests or operations.[143] There

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[137] Ronald Kostoff, 'Simulating Discovery' in Klaus P. Jantke and Ayumi Shinohara (eds.), *Discovery Science: Proceedings of the 4th International Conference, Washington, D.C., November 2001* (Heidelberg: Springer-Verlag, 2001), pp. 196-197.
[138] MacKenzie, p.13.
[139] See, for example, the discussion in Rui Baptista, 'The Diffusion of Process Innovations: A Selective Review', *International Journal of the Economics of Business*, 6:1 (1999), pp. 107–129. Cited in Cragin, et. al., p. 14.
[140] Ortiz, pp. 219-221.
[141] For more on the effects of the PIRA training and technology transfer, see Cragin, et. al., pp. 72, 82, 85.
[142] Ortiz, p. 219.
[143] Jackson, et. al., *Aptitude for Destruction, Vol. 1*, pp. 63-67.

are many examples of terrorists becoming markedly more proficient in their operations over time, either unilaterally or in response to countermeasures, including Iraqi insurgents' incremental improvements in the efficiency of disseminating chlorine from 2006 to 2007,[144] and Hizb'allah's increasingly sophisticated remotely-detonated roadside bombs in the 1990s, which presaged a similar escalation against U.S. forces in Iraq ten years later.[145]

Of course, the organization must have sufficient space, time and resources to engage in an iterated adoption process, factors that have already been alluded to above. However, there are two major facilitators of a sustained process of step-wise improvements until adoption success is reached. The first is the ability of the organization to learn from its failures and correct past mistakes in subsequent iterations. This is not always easy, as it requires the organizational capacity to recognize what went wrong, to internalize this information in some form of institutional memory and then to reorient organizational functions and operations to make an adjustment in the direction of eliminating the shortcoming. Those terrorist organizations which embody these qualities more than others can thus be expected to have a relatively greater chance of succeeding in their adoption efforts over time. Examples of terrorist groups that have been described as being particularly adept at organizational learning are the FARC and the LTTE.[146]

The second major facilitator of an iterative process of adoption is an expectation of success, which inculcates the motivation to persevere despite setbacks. In the general organizational sense, MacKenzie, through the use of several enlightening case studies, has shown that the ultimate success or failure of a technological innovation is to at least some extent dependent on actors' beliefs and expectations about its future efficacy. He argues, for example, that if actors believe that a given technology will succeed, this lends impetus to tinkerers, prompts investment in the technology and encourages adoption by system members, thus making creation and diffusion of the technology more likely, in something akin to a self-fulfilling prophecy.[147] In a related vein, organizations that have already sunk substantial costs into an innovation are viewed as

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[144] Smithson, p. 86.
[145] Kim Cragin, 'Hizballah, the Party of God' in Jackson, et. al., *Aptitude for Destruction Vol. 2.*, p. 49; Forest, pp. 21-22.
[146] Ortiz, for example, maintains that the 'FARC's survival and expansion have been possible thanks to its notable capacity for learning' (Ortiz, p. 208), while the LTTE was notorious for engaging in long-term R&D.
[147] McKenzie, p.7 and passim.

being less likely to abandon an effort because this would mean admitting that the resources already used have been wasted. In the case of WMD, for example, O'Neil asserts that 'groups which invest enormous amounts of time, energy, and resources in endeavouring to acquire these capabilities have a very strong incentive to succeed, which itself should not be underestimated as a factor'.[148]

Reinvention, or the modification and adaptation of an innovation by the adopter during the diffusion process to suit the adopter's unique needs, is likely to be a key aspect of terrorist innovation adoption. Reinvention is said to occur when the adopting entity needs to adapt an innovation to fit in with its existing structure,[149] and is more likely with innovations that are relatively difficult to understand[150] or those that represent a generalized concept with multiple possible applications.[151] If a particular innovation is accompanied by a high degree of reinvention, it is argued to be more likely to be adopted more rapidly, and enjoy a higher degree of sustainability.[152] Indeed, in many cases extensive modification or adaptation can result in the most efficient or popular form of an innovation differing considerably from the initial version that was available for adoption.[153]

Terrorists and Weapons Adoption

The terrorist innovation and general diffusion of innovations literature introduces many of the core elements present in any terrorist adoption process. Yet, the terrorist adoption of weapons in particular might carry salient features that require greater exposition than the adoption of other innovations. Among the few detailed references to weapons attributes as these relate to terrorists, Jackson and Frelinger list various attributes that differentiate weapons used by terrorists, namely stand-off distance, capacity for use in parallel and the option of trading human for technical resources.[154] Palfy describes

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148 Andrew O'Neil, 'Terrorist Use of Weapons of Mass Destruction: How Serious is the Threat?' in Howard and Forest, p. 67.
149 Ann Majchrzak, et. al., 'Technology Adaptation: The Case of Computer-Supported Inter-Organizational Virtual Teams', *MIS Quarterly*, 24:4 (2000), pp. 569-600.
150 Judith K. Larsen and Rekha Agarwala-Rogers, *Reinvention of Innovation: A Study of Community Health Centers* (Palo Alto, CA: Report of the American Institute for Research in the Behavioral Sciences, 1977).
151 Rogers (2003), p. 186.
152 Rogers (2003), p. 183.
153 Chesbrough, p. 13.
154 Jackson and Frelinger, p. 27.

several other aspects, which are specific to weapons, as important in this regard, including life span, stability, environmental persistence and methods of dispersal.[155] However, he does not state how these factors might facilitate or retard adoption. To this list can be added several more attributes, including level of concentration of lethal effect, and capacity for covert delivery, to name just two.

Furthermore, the general innovation literature identifies several attributes attaching to an innovation that can exert a significant influence on the adoption process, including its trialability, observability and complexity. Especially in situations where an actor is competing for support, which is almost always the case with terrorists, observability might be particularly important, not only in terms of whether the terrorists, as potential adopters, are aware of the weapon, but also in terms of the weapon's effects on various external and internal audiences. This suggests, for example, that weapons associated with the latest scientific and technological advances, in other words, those that are seen as being on the 'cutting edge', might be especially attractive to many terrorists. It can also be proposed in the terrorism context that the more testing that is required to adopt an innovation, the greater the chance of either accidental self-harm or detection (and hence interdiction) by authorities and thus the lower the chances of ultimate success in the adoption process.

From a purely pragmatic perspective, the terrorism literature does identify three primary elements with respect to terrorist weapons selection: a) desired attack outcomes (i.e., the terrorists' operational goals and preferences, which are determined by a multitude of variables, among which ideology features prominently);[156] b) the nature of the weapon or weapon technology itself;[157] and c) the characteristics of the intended type of target(s).[158] While the relationship between these three elements is by no means unidirectional, it should be theoretically possible, at least, for a terrorist group to select the weapon that best matches its operational goals with respect to a particular target or set of targets, including desired levels of casualties, physical damage, publicity, or psychological impact.[159] If their current arsenal is perceived to be inadequate to achieve

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[155] Palfy, p. 88.
[156] Gressang, pp. 89-90; Jackson and Frelinger, p. 23.
[157] Jackson and Frelinger, p. 15.
[158] Jackson and Frelinger, p. 15; Palfy, pp. 83-84.
[159] See Palfy, pp. 86-87, for a similar notion. Jackson and Frelinger (p. 25) take this idea further by classifying alternate terrorist weapons *strategies* as either 'versatility' strategies, where a limited

their attack goals in general or against a given target, or is at least judged to be inefficient in doing so, terrorists may initiate a search for new weapons.[160]

However, while this may provide a basic logic for terrorist weapons *choice*, it does little to explain the *process*. What is required for a fuller understanding is a synthesis of all of the factors that can influence the process of terrorist weapons adoption. Both this chapter and the last have shown that the set of three premises above is obviously just the starting point for understanding terrorist weapons adoption, as innovation and the diffusion of innovations are neither simple nor free-flowing processes. There are numerous countervailing forces that invariably act to oppose either the generation or adoption of innovations and multiple failure points at which these forces can bring innovation processes to an abrupt halt. Terrorist organizations are not immune from these forces for the status quo, and might even be singularly susceptible to some of them. Yet this clearly cannot be the whole story, since terrorist groups do fairly regularly decide to adopt new weapons and methods of using them, and sporadically succeed in doing so. By surveying the literature on innovation in general and terrorist innovation in particular, this chapter has provided numerous clues as to how the process of weapons innovation adoption by terrorists occurs and how terrorist actors might surmount existing obstacles to becoming aware of new weapons, deciding to adopt them and succeeding in that adoption. It has also highlighted that many of the same factors operate at multiple stages of the adoption process, but can have different effects on outcomes, for instance, between the decision and implementation phases. However, beyond the basic criteria of relative advantage over existing methods, feasibility and compatibility, none of the factors introduced above have been unequivocally shown to be either necessary or sufficient for weapons adoption and thus none can be construed as strictly causal in nature.

To summarize the use of prior scholarship, the previous chapter cast a close theoretical and historical eye on weapons as the objects of adoption, whereas the very different literature reviewed in the current chapter examined innovators and the process by which innovation occurs, where possible focusing on the terrorism context but drawing

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repertoire of more versatile weapons like firearms and bombs is maintained, versus ‘variety’ strategies where a multiplicity of weapons are acquired in order to address a range of possible attack configurations.
[160] There are other innovation options, of course, including scaling back desired outcomes or shifting targets.

regularly on wider innovation studies. Despite approaching the central question of this study from two different perspectives (which I have termed 'inside out' and 'outside in'), however, the results of these inquiries have much in common. For example, both chapters highlight the dangers for successful adoption from organizational guardians of the status quo and cultural incompatibilities. Furthermore, both allude to the degree to which the potential innovation and its effects are observable to outsiders as influencing the adopter's awareness and decision to adopt. Each approach also yielded some important factors not found in the other perspective. The general (and terrorism specific) innovations literature, for instance, has almost nothing to say about the weapons perspective's recognition of the possibility of active efforts to deny adopters access to weapons or the need to incorporate both the physical weapon and its support systems in order for adoption to be successful. At the same time, the innovations literature provides far more detail on various aspects of the emulation dynamic. Overall, almost every insight uncovered in the various literatures studied has some bearing on terrorist weapons adoption and will be utilized to inform the adoption model presented in the following chapter.

Chapter 4: Development of a Terrorist Weapons Adoption Model

The preceding reviews of the various literatures on weapons and innovation have distilled a central overriding logic of terrorist weapons adoption, namely, that entities will likely attempt to adopt new weapons when faced with a disparity between the performance sought and that provided by their current weapons. This is quite straightforward, but also somewhat unhelpful in both a practical and theoretical sense because, short of a terrorist leader actually being overheard stating to a colleague that he or she is unhappy with their current arsenal, it does little to help understand or anticipate actual instances of weapons adoption. At the same time, the literature posits a plethora of forces and factors that might enhance, distort or otherwise influence this central logic. It is thus clear that for the current research question, the devil, as they say, is in the details and the adoption process cannot be adequately explained or described by reducing it to a single hypothesis. Once this has been accepted, the enumeration by various theoretical literatures of an array of independent variables together with three dependent variables of primary interest (weapon awareness, the adoption decision, and adoption success), calls for some theoretical structure, i.e., a model, that can act as a heuristic device to make sense of the multitude of factors that might have some causal, contributing or modifying effect on the weapons adoption process.

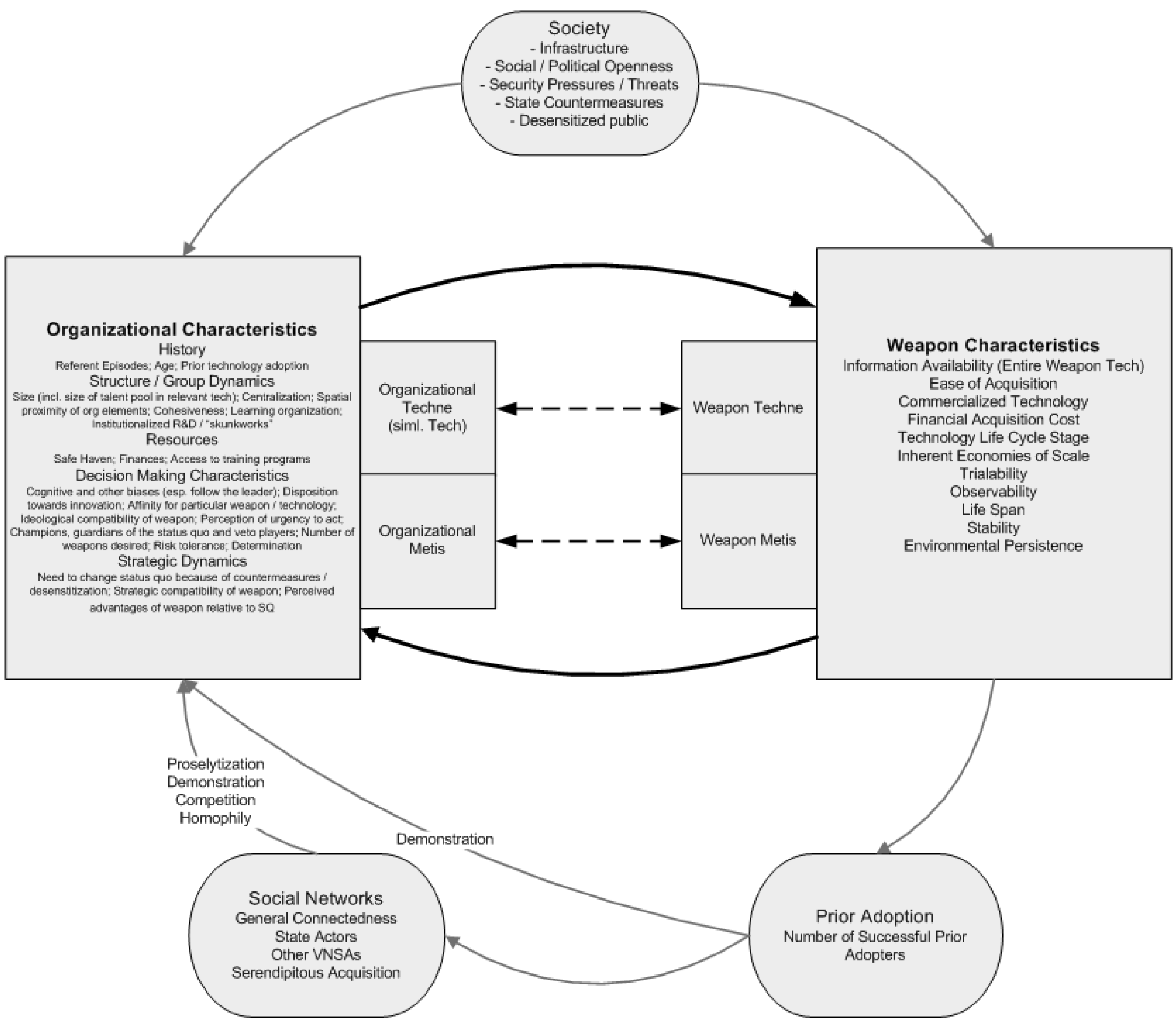
Drawing on the reviews of the literature and reflecting on the roles of the multiple factors involved, a preliminary theoretical representation of terrorist weapons adoption was developed, upon which a model of terrorist weapons adoption could be built. This is shown in diagrammatic form in Figure 4.1 below. The representation is loosely based on a contributing factors approach,[1] and focuses on the influencing factors themselves and the adoption process as a whole, rather than which of the three dependent variables is being affected. In other words, it is intended to illustrate the basic connections between influences on the adoption process in a stage independent sense, which is useful since many of the independent variables are hypothesized to affect more than one (or indeed all three) of the dependent variables under consideration. As such, the diagram depicts the core of the adoption process with respect to a particular candidate

[1] G. Ackerman et. al., *Assessing Terrorist Motivations for Attacking Critical Infrastructure*, p. 113. These are similar to the commonly-used concept of influence diagrams; see Apiruk Detwarasiti and Ross D. Shachter, 'Influence diagrams for team decision analysis', *Decision Analysis* 2:4 (December 2005), pp. 207–222 and, for an application to the terrorist context, see Ferguson, pp. 122-138.

weapon as an interaction between several organizational characteristics of the terrorist group with the more technical aspects of the weapon itself.

The diagram highlights as a particularly important relationship the level of congruence between the skills and knowledge required to acquire, produce or field the weapon (encapsulated in the twin measures of *techne* and *mētis*) with those possessed by the organization. Surrounding this central interaction is the effect of broader environmental factors on both the weapons and the terrorist organization, as well as the impact of past adoption efforts and the influences exerted by the social networks within which the terrorist group operates.

Figure 4.1: Representation of Influences on the Terrorist Adoption of New Weapons



While including characteristics common to all weapons, the diagram does not explicitly include the myriad tactical attributes of weapons described in the previous chapter. This is primarily owing to the large number of such characteristics, only a handful of which are likely to be relevant in any particular operational context, which in turn is shaped by both organizational goals and the strategic and operational environment. Instead, the tactical features of the weapon are encapsulated within the portion of the framework that considers the 'Perceived advantages of the weapon relative to the status quo,' which thus incorporates such attributes as stand-off distance, concentration of lethal effect or capacity for use in parallel, but does so in the specific context of the group's strategic and tactical exigencies.

Owing to the predilection in much social science towards simple, if not univariate, explanations for social phenomena, some justification is needed for retaining so many variables in an initial model. First, existing literature and empirical experience in other domains suggests that there are indeed many factors that impact the process, with no clear indications that one or two factors predominate in most cases of adoption. Indeed, the outcomes most likely result from the convergence of several factors, rather than any single factor or variable.[2] Since the current research endeavour is at such an early stage, it would thus be premature to discard any potentially salient or essential factors merely for the sake of parsimony. As George and Bennett opine, 'At the frontiers of research, … social scientists need to discard stylized simplifying assumptions and build upon the most accurate microlevel mechanisms that can be discerned.'[3] In addition, there is every indication from the literature consulted that weapons adoption, at least when considered at any useful level of detail, is likely to be an equifinite process, in other words that there can be multiple causal pathways leading to the same outcome. In such circumstances of complexity, one would be rash to ignore possibly fruitful avenues of research purely owing to an abstract obsession with parsimony. After all, King, Keohane and Verba caution that, 'Parsimony is a judgment, or even an assumption about the nature of the world.…In the social sciences, some forcefully defend parsimony in their subfields, but we believe it is only occasionally appropriate ….theory should be just as complicated as all our evidence suggest.'[4]

[2] This situation is discussed in George and Bennett, p. 212.
[3] George and Bennett, p. 212.
[4] Gary King, Robert O. Keohane and Sidney Verba, *Designing Social Inquiry* (Princeton, NJ: Princeton University Press, 1994), p. 20.

This basic theoretical structure can now be recast in terms of the existing adoption process framework (described in Chapter 1) and used to produce a theoretical model that incorporates and synthesizes existing hypotheses about terrorist innovation and empirical results from the broader innovation literature. The resulting Terrorist Weapons Adoption Model thus consists of three connected, but independently evaluated, sub-models:

1. **Awareness Sub-Model**: this model represents the interaction between a set of observable characteristics (potential contributing factors) and whether or not a terrorist organization will be aware of a particular weapon, i.e., it has a binary dependent variable that can take the values 'Aware' and 'Not Aware'.
2. **Adoption Decision Sub-Model**: assuming awareness, this model assesses the interaction between a set of potential contributing factors and whether or not the terrorist organization decides to attempt to adopt the weapon under consideration, i.e., it has a binary dependent variable that can take on the values 'Decision to Adopt' and 'No Decision to Adopt'.
3. **Outcome Sub-Model**: assuming an attempt to adopt the new weapon, this model assesses the interaction between a set of potential contributing factors and whether or not the attempt is successful. In this case success is defined as the organization acquiring a relatively reliable capability to acquire and deploy the weapon to cause the level of harm or other effects intended by the group, rather than whether the adoption of the weapon actually furthered the group's broader political, ideological or social goals. The model has a binary dependent variable that can take on the values 'Successful' and 'Unsuccessful'.

Each sub-model was constructed according to the same procedure. Each contributing factor shown in Figure 4.1 (treated as an independent variable) was considered separately to determine *how* it might affect the individual dependent variable under consideration. More specifically, the factor was scrutinized in terms of both the direction of the independent variable's effect on the dependent variable, and the relative magnitude of that effect, thus generating a hypothesis with respect to that factor. The hypothesis generation process consisted primarily of applying and adapting either: a) insights from other domains, as highlighted in the literature reviews, to the terrorist context, or b) existing insights from other aspects of terrorist behaviour to the specific context of adoption. An example of a) is the notion in general innovation studies that a high degree of homophily (commonalities in culture, ideology, ethnic origin, etc.) with an entity that demonstrates or advocates for an actor to adopt an innovation, makes the adopter more likely to decide to do so,[5] which in the terrorism context implies that terrorist organizations would be more likely to accept an innovation already adopted or endorsed by its constituency or peer groups. An example of b) is the general notion in terrorism studies that intergroup competition leads to a dynamic of 'outbidding'[6] and a general escalation in terrorist actions; all else being equal, this might manifest in a greater openness to adopting a new weapon.[7]

In cases where the literature only suggests a relationship of a factor to one sub-model, it was considered whether similar effects might apply to the other dependent variables. As a result, many (but by no means all) of the independent variables have hypothesized relationships to more than one sub-model, making it efficient to represent the hypotheses in tabular form. The final model, including all three sub-models, is shown below, as Table 4.1.

Table 4.1: The Terrorist Weapon Adoption Model

Independent Variables	Dependent Variables		
	Awareness	Decision	Success
SOCIETY			
Developed Infrastructure	++	+	+ to ++
Social / Political Openness	++		~ to +
Intense Security Pressure	– to +	– to +	– –
SOCIAL NETWORKS			
Highly Networked (in general)	+		+
Highly Networked (with other violent non-state actors)	++		++
Demonstration – 1st degree (by an actor in its own network)	++	++	+
Cultural Affinity (homophily) with Relevant Network Node		++	+
Proselytization (change agents / opinion leaders)	+++	– – to +++	~ to ++
State Sponsorship	~ to +		++
Serendipitous Acquisition	~ to +++	+++	~ to ++
Intergroup Competition		+ to ++	
PRIOR ADOPTION (Outside the Organization)			
Demonstration – 2nd degree (by an actor out of its network)	+	+	
No. of Successful Prior Adopters [Linear]	[+]	[++]	[+]
ORGANIZATIONAL CHARACTERISTICS			

[5] See Strang and Meyer, p. 490.
[6] See Bloom, pp. 162-163 in the previous chapter.
[7] The author would like to thank Dr. John Sawyer for his input in formulating the various hypotheses during a related research project. However, all final choices and decisions regarding the hypotheses, and thus any errors or omissions, reside with the author.

History			
Age of Group (more than 5 years or not)			+
Prior Autarkic Technology Adoption	+	+ to ++ (similarity to tech required for current weapon)	+
Prior Technology Adoption Outcomes [Linear]		[+]	[~ to +] (similarity of new tech to old)
Structure / Group Dynamics			
Size [Large]	+	+	+
Size [Small]		–	
Size [Micro]	~ to –	+	–
Size of Talent Pool (with Techne & Mētis) [Large]	+	+	+
Size of Talent Pool (with Techne & Mētis) [Small]		~ to –	~ to –
Centralization [Low]	++	+ to ++	
Centralization [High]			+
Spatial Proximity of Organization Elements			+
Learning Organization	++	+	++
Possesses Institutionalized R&D / "Skunkworks"	+++	+ to ++	++
Cohesiveness (lack of intragroup competition) [Linear]		[+]	[+]
Resources			
Organizational Techne (Similar Technologies to Weapon) [High]	+	++	++
Organizational Techne (Similar Technologies to Weapon) [Low]	–	–	–
Organizational Mētis [High]	+	+++	++
Organizational Mētis [Low]		– –	–
Org. Knowledge Type Ratio [High Techne/Mētis]			–
Org. Knowledge Type Ratio [Low Techne/Mētis]		+	–
Safe Haven	+	+	+
Surfeit of Resources (esp. financial)	+	+	+
Access to Training Programs [Linear]	[++]	[~ to +]	[+]
Decision Making Characteristics			
Cognitive and Related Biases	~ to – – –	Contingent	– – – to +
Follow-The-Leader Bias (prior technology leader)	++	++	Contingent
Disposed Toward Innovation	+ to ++	++ to +++	
Disposed Away From Innovation	~ to –	– – –	
Affinity for the Weapon/Technology	~ to ++	+++	
Ideological/Cultural Compatibility with Technology [High]	+		
Ideological/Cultural Compatibility with Technology [Low]		– to – – –	–
Perception of Urgency (limited time to act)	~ to –	– –	–
Champion in Leadership		+++	+ to ++
Veto Players Exist Within Leadership Structure		–	~ to –
Guardians of Status Quo [Linear]	[–]	[–]	[~ to –]
Multiple Weapons Needed/Desired		–	– to – –
Risk Tolerance [High]		+ to +++ (depends on overall riskiness of technology)	
Risk Tolerance [Low]		– to – – – (depends on overall riskiness of technology)	
Determination			++
Strategic Dynamics			
Active Searching	++	+ to +++	
Δ Status Quo Needed: Overcome Countermeasures		+ to ++	
Δ Status Quo Needed: Overcome Desensitized Public		~ to ++	
Perceived Advantages of Technology (vis-à-vis SQ)		++	
Compatibility between Strategy and Technology	~ to +	~ to +	+
Perception of Ease of Acquisition / Feasibility		+++	
WEAPON CHARACTERISTICS			
Information Availability Relative to the Entire Technology [Low]		– – to ++ (dependent on content)	– –

Information Availability Relative to the Entire Technology [High]	++	– – to ++ (dependent on content, i.e. degree of difficulty)	+
Weapon Techne [Linear]	[~ to –]	contingent on group preferences for challenge	[–]
Weapon Mētis [Linear]		contingent on group preferences for challenge	[–]
Knowledge Type Ratio (Techne/Mētis Required to Field Weapon) [High]		++	~
Knowledge Type Ratio (Techne/Mētis Required to Field Weapon) [Low]		–	~
Ease of Acquisition			++
Commercialized Technology	+ to + +	+ +	++
Financial Acquisition Cost [High]		– to – – –	
Financial Acquisition Cost [Low]		+	+
Technology Lifecycle [Early]			~ to –
Technology Lifecycle [Late]			+
Economies of Scale		+	
Trialability of Technology [Linear]		[+]	[+]
Observability of Technology [Linear]	[++]	[+]	[+]
Life Span of Technology [Linear]		[+]	
Stability of Technology [Linear]		[+]	[+]
Environmental Persistence of Technology	+	– – – to +++ (depends what is being affected)	
Active Opposition of Possessors of Technology	– – – to + (depends on technology and opposition strategy)	–	– to – – –

A few notes regarding the interpretation of Table 4.1 are warranted:

- The different sub-models and their dependent variables are represented by the columns, with the various potential contributing factors represented by the rows of the table.
- For the dependent variables, the value shown in the table applies to the positive outcome (i.e., being aware, making a decision to adopt and succeeding in adoption).
- Each independent variable is listed in the first column, with additional information to lend context to the variable shown in parentheses. These are drawn from the previous two chapters, which can be consulted for greater detail about the meaning of a variable.
- The values for each of the independent variables are given in square brackets. To reduce the size of the table, the absence of square brackets next to a factor denotes a binary variable, with a positive outcome (if the negative outcome is not shown, it can be assumed that the absence of that variable has no

hypothesized effect on the dependent variable). For example, the State Sponsorship variable shows the hypothesized effects on the awareness and success outcomes if the organization does have a state sponsor; if it does not, there is no hypothesized effect on any of the dependent variables.

- The direction of effect of each independent variable on each dependent variable is denoted by a positive sign for a positive effect and a negative sign for a negative effect. The number of positive or negative signs denotes the hypothesized strength of the effect relative to other variables and roughly corresponds to small, medium and large effects for one, two or three symbols in a cell. However, the largest possible effect in the model (in order not to prejudice any single factor at this stage of the inquiry) is limited to '– – –' or '+ + +'. For many variables, the literature provides little guidance as to the relative magnitude of the hypothesized effects, so the best estimate based on prior knowledge of terrorist behaviour was resorted to in these cases.
- A blank cell implies that the independent variable is not hypothesized to have any effect on the outcome of that particular dependent variable.
- Where the table shows an effect for 'High' and 'Low' values of the variable, and does not explicitly show a 'Medium' value, it can be assumed that there is no hypothesized effect for a value of 'Medium' on the independent variable.
- Some cells display a range of possible effects (with '~' representing a null effect), to be determined in a particular case depending on the contextual factors specific to that case and/or the strength of the independent variable. Where the effect is dependent on a specific characteristic of the organization or circumstance, this is noted in the cell.
- If the independent variable is followed by the word 'Linear' in square brackets, this denotes that the independent variable can take a range of values and that the higher the value, the stronger the effect is in the direction indicated in the adjoining cell. So, for example, even if the 'Number of prior adopters' variable has a '+' associated with it in the Awareness column, this means that if the number of prior adopters is zero, the effect will be neutral, if there have only been a handful of former adopters the effect would be '+', but if there have been a dozen or so prior adopters, the effect will be '++' and so forth.

Selecting a particular column in the table and reading from top to bottom gives one a sense of how the different independent variables as a whole are hypothesized to affect the dependent variable. In attempting to strike the correct balance between parsimony and complexity, the table contains some implicit weighting of the factors, but it does not delve too deeply into possible interaction effects between variables or differences in weighting determined by contextual factors of a particular case since this would greatly increase the complexity of an already sizeable model. However, basic interaction effects are occasionally captured when the model indicates a range of effects contingent on other variables, especially in cases where the precise effect is clearly dependent on other characteristics of the group or circumstances.

The model is thus only a first-level, mostly linear synthesis of the hypothesized effects of the various contributing factors. A basic use of the table is simply to assign 'scores' to each independent variable with respect to the sub-model under consideration and then to sum these scores arithmetically to obtain a total 'score' for the particular case with respect to awareness, success and so forth. Such scores are usually useful only in a relative sense (such as comparing them across organizations or time periods), and more complex combinations of factors are of course possible in future iterations of the model (discussed in the concluding chapter).

Now that the expansive theoretical landscape relevant to terrorist weapons adoption has been encapsulated in a tractable model, it is possible to evaluate and expand upon the theory by examining terrorist weapons adoption in an empirical manner.

Chapter 5: Case Study Methodology

The terrorist weapons adoption model, which synthesizes knowledge and theory about innovation adoption from several domains, incorporates a multitude of hypotheses regarding the process of how terrorists might become aware of sophisticated weapons systems and make the decision about whether or not to pursue them, as well as the factors contributing towards the success or failure of these efforts. Yet, having developed a theory of the process of terrorist weapons adoption, it is clear that few, if any, of these hypotheses have ever been systematically investigated in real-world instances of terrorist weapons adoption. It is to the empirical exploration of terrorist weapons adoption behaviour that this portion of the study now turns.

The primary vehicle through which this will be accomplished is a series of case studies. Case studies are well-suited to research programs at a relatively early stage, as with the current endeavour, for several reasons. First, the case study method is often better suited to examining the causal processes involved than alternative methods, such as formal modelling or large-N analysis.[1] This is especially true when such processes are likely to involve what George and Bennett have termed 'complex causality', which includes multiple, possibly interacting variables, feedback loops and equifinality.[2] Second, case studies can prove extremely useful in inductively identifying additional variables and generating hypotheses, an indispensable asset in the preliminary stages of any research endeavour. Case studies are well-suited to such exploratory inquiries because they are not restricted to a given number of variables that are easily quantified, or for which systematically coded data exists.[3]

The case studies presented here were therefore designed with two primary objectives: a) to explore the dynamics of the weapons adoption process in greater detail through historical example and thereby to identify any possible omitted variables in the model not covered in the available theoretical literature; and b) to provide a preliminary test of

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[1] Stephen Van Evera, *Guide to Methods for Students of Political Science* (Ithaca: Cornell University Press, 1997), p. 54. However, while their strengths lie in determining whether and how variables impact outcomes, case studies are less useful for assessing the magnitude of these impacts (George and Bennett, p. 25).
[2] George and Bennett, p. 10.
[3] George and Bennett, pp. 20-22, 45.

the validity of the model by examining the interaction of independent and dependent variables in an application of the model to real-world cases.

Obviously, a limited number of case studies cannot provide a definitive test of the model. Deeply engaging with historical cases can, however, provide *prima facie* support for the model or indicate serious flaws therein, as well as refining the theory and guiding future research. In this respect, the case studies will, to some degree, make use of all three of the main approaches for testing theories with case studies identified by Van Evera, namely, controlled comparison, congruence procedures and process tracing,[4] although the focus will be on the latter two, since controlled comparison does not handle equifinality very well.[5] This will consist of a nested design of two sets of paired case studies in order to maximize inferential leverage through what Tarrow has referred to as 'dual-process tracing'.[6] This research design, which is inspired by case-control methods,[7] allows for multiple within-case and cross-case observations, thus getting the most out of the cases in terms of opportunities to investigate the phenomenon and test the model.

Case Selection

This is a crucial part of any research design and is inevitably bounded by the availability of historical examples, the richness of available data, and investigator resources. Going beyond these minimal criteria, however, I selected for both positive and negative outcomes in order to explore both the operation of the independent variables and the performance of the model as a whole across both types of outcomes. Thus, one aim of the selection process was to obtain as much variance as possible in the outcome variables under consideration (awareness of new technologies of lethality, the adoption

[4] Van Evera, pp. 56-67.
[5] George and Bennett, pp. 157, 161.
[6] Sidney Tarrow, 'The Strategy of Paired Comparison: Toward a Theory of Practice', *Comparative Political Studies* 43 (2010), p. 244. Tarrow generally argues that paired comparison possesses advantages lacking in either single-case analysis or multi-case comparison (p. 230).
[7] Case-control methods are sample design and analysis strategies involving both 'cases' and 'controls' that disproportionately stratify a binary dependent variable sample (see Michael G. Lacy, 'Efficiently Studying Rare Events: Case-Control Methods for Sociologists', *Sociological Perspectives*, 40:1 (1997), p. 129). While they are a quantitative method usually applied to large-N data, they served as a guide for structuring the case studies, which borrowed several of their ideas, such as those concerning matching controls to cases. For an example of case-control methods being applied in the terrorism context, see Alberto Abadie and Javier Gardeazabal, 'The Economic Costs of Conflict: A Case-Control Study for the Basque Country', *National Bureau of Economic Research Working Paper 8478* (2001).

decision and the success or otherwise of any attempted adoptions).[8] Despite many social science methodologists (especially those of the quantitative ilk) decrying selection on the dependent variable, for certain purposes – including theory development and establishing the necessity or sufficiency of certain variables – even a single case selected on a positive outcome can be appropriate.[9] This is argued to be a particularly valid approach when cases have substantial within-case variance and are sufficiently data rich to analyse using process tracing,[10] two criteria that were used in the current study.

Of the three dependent variables, the adoption decision was prioritized over the other two with respect to case selection, as a greater understanding of the determinants of this variable is arguably the most relevant in terms of terrorism scholarship and counterterrorism policy. Thus, for the two paired case comparisons (four cases total) that were sought, particular preference was given to cases where one terrorist entity of the pair attempted to adopt a specific weapon, while the other member of the pair did not (i.e., to ensure variance in adoption decision). Nevertheless, at least some variance was sought in awareness of the technology and in adoption success.

Moreover, upon examination of the elements in the model, the vast majority of the model factors pertain to organizational aspects of the terrorist group itself, with a fair amount also related to intrinsic aspects of the weapon technology. Therefore, the case analysis was focused on analysing these aspects, which resulted in controlling for macro-social factors and basic ideological orientation within each case pair. At the same time, it was desired that at least an initial attempt be made to ascertain the extent to which any results were generalizable beyond a single weapons technology, extremist ideology or geographic locale.

Ultimately the criteria for case selection consisted of identifying two sets of cases involving at least two different weapons, countries and ideological contexts, and within each set identifying cases where the ideological and socio-political context was constant (but organizational factors were likely to differ), while obtaining as much variance as

[8] Limitations on space did not permit comprehensive exploration of variance for all three binary variables, which would have required eight case studies, even assuming that the requisite cases could be located in the empirical record (which is highly doubtful).
[9] See the discussion in George and Bennett, p. 23.
[10] Van Evera, p. 47.

possible on the dependent variables relating to the adoption process (especially the adoption decision itself).[11] In addition, sufficiently rich and detailed data had to be available to permit process tracing and within-case variation over time, a criterion that had to be balanced against avoiding bias in favour of the most well-studied and often-cited cases.[12]

Both historical databases of terrorist groups and various experts in the field were consulted and a number of potential sets of cases were subject to preliminary investigation in order to examine how closely these matched the aforementioned criteria. In certain instances, this revealed that the cases were unsuitable,[13] and the potential cases were excluded from consideration. The cases that were ultimately selected via this process were:

a. **The Provisional Irish Republican Army (PIRA)** and the **Irish National Liberation Army (INLA)** with respect to the adoption of mortar technology in the 1970s through the 1990s. Both these groups fought for a unified Ireland against the British at approximately the same time, whereas the PIRA successfully adopted a range of improvised mortars, while the INLA did not even attempt to do so.

b. **The Covenant, Sword and the Arm of the Lord (CSA)** and the **Order** with respect to two separate lethal technologies (cyanide and rockets) in the early 1980s. Both groups were driven by a far right, white supremacist ideology and operated in the United States during the early 1980s. Although neither was successful in adopting any novel technologies of lethality, the CSA attempted to adopt several new weapons, while the Order was largely content with utilizing guns and simple explosives.

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[11] This would ensure that one case in each paired set would proceed at least as far as the adoption attempt stage, thus allowing for at least some analysis of the outcome of the adoption process in terms of its success or otherwise.
[12] See George and Bennet, p. 51, for warnings against this bias, which is one of the reasons the Aum Shinrikyo case was not selected, since it was felt that many of the theoretical arguments in the literature were influenced by this case. The other reason for not selecting this case, is that there was no good Japanese, apocalyptic cult analogue that did not attempt to procure WMD.
[13] For example, initial indications were that HAMAS had tried to use chemical weapons while the Palestinian Islamic Jihad (PIJ) had not (Jerrold Post, Ehud Sprinzak and Laurita Denny, 'The terrorists in their own words: Interviews with 35 incarcerated Middle Eastern terrorists', *Terrorism and Political Violence*, 15:1 (2003), pp. 171-184) whereas closer examination and consultation with experts in Israel revealed that PIJ had recently attempted to use chemical agents as weapons, thus limiting the variance in the dependent variable of the decision to adopt and making the case less suitable.

Data Collection

As a starting point, for each of the four organizations under investigation, an intensive survey was conducted of publicly available secondary sources relating to the organization. These included books by both scholars and investigative journalists, news reports, peer-reviewed journal articles, television documentaries, and various governmental and non-governmental reports. These sources were supplemented by primary source investigation. In the case of the PIRA and INLA, this predominantly took the form of field research in Northern Ireland, the Republic of Ireland and England and consisted of archival research, as well as in-person interviews with former law enforcement and intelligence officials, journalists, academic researchers and in one case a former PIRA bomb-maker.[14] For the CSA and Order studies, owing to the fact that in the United States access to law enforcement and perpetrators is much more restricted, the predominant primary sources consisted of court documents (trial transcripts, judicial orders, affidavits, articles of admitted evidence, and so forth), as well as declassified law enforcement documentation, obtained through Freedom of Information Act requests.

All data sources on terrorism present potential difficulties for analysis. For example, secondary sources can misreport events or limit the scope of their coverage, while primary sources (and especially in-person interviews) can result in misleading accounts. Such distortions can be either intentional or unintentional and can result from a variety of factors, ranging from prejudiced self-interest to memory deficits. Therefore all sources in a highly politically charged domain such as terrorism-related research should be approached critically. However, intentional bias was expected to be somewhat less severe in the current study than in much other research on terrorism, since the study focused on the generally less emotionally laden 'logistical' decisions of terrorists rather than on their ideological and political beliefs, victim selection or internal loyalties, where incentives might exist for manipulating the truth. In either event, the best means by which to ensure reliable and credible evidence for a case study is to utilize a multitude of independent sources, preferably including those with competing inherent

[14] These were semi-structured interviews, with a similar set of questions being posed to each respondent, while allowing for the discussion to branch into additional avenues related to the topic.

biases, and to verify congruence between them. Therefore, as many sources and types of sources as possible were sought in the case studies, including employing primary sources from both the terrorists and their government opponents (and from different government agencies where possible), as well as third party observers. No clear instances of intentional dissembling were detected.

In sum, the entire gamut of available sources was consulted, with every effort made to corroborate information from multiple sources where possible and the provenance of information taken into account at all stages. The quantity of available information varied from case to case, but succeeded in addressing the vast majority of independent variables in the model and in all instances was sufficient to enable within-case analysis.

Data Organization

In order to develop a structure around which the different cases could be consistently analysed, several longitudinal matrices were constructed for each case. The first set of three matrices, each one dealing with one of the dependent variables (awareness, decision and success), were structured similarly, with any information relevant to actual adoption behaviour mapped to the relevant matrix at the time period when it occurred.[15] For the two Irish Republican organizations and the CSA, time periods were designated in years, while for the Order, considering its relatively brief lifespan and intense activity, the time periods were designated in months. These matrices thus captured changes in the three dependent variables over time.

A longitudinal matrix for each case was also constructed to reflect the case context. The columns of this matrix represented the different time periods and the rows a host of contextual factors. These contextual factors included all of the independent variables in the model (see the previous chapter), as well as some broader descriptors, such as major events in the history of the organization or significant leadership changes. Each cell in the matrix thus contained evidence related to a specific independent variable or

[15] Allowances were made for reflecting indeterminate time periods (such as events occurring over several years or where the sources did not provide a time when an event occurred) by having a separate column for ‘indeterminate time / throughout the period’ and where a particular factor extended over multiple years, listing it in the first year that it occurred and inserting an addendum noting the period over which it extended.

contextual factor in a specific time period. Additional rows were added when there was more than a single piece of evidence pertaining to a specific time period.[16] The categorization of each piece of evidence in a longitudinal matrix in this way facilitated both process tracing and cross-case comparison.

Data Analysis

The first analytical technique utilized on each case separately was process tracing, which 'explores the chain of events or the decision-making process by which initial case conditions are translated into case outcomes'.[17] By identifying when a change in the dependent variable occurred and then systematically working backwards utilizing the matrices, a likely causal chain was established that traced the outcome to specific changes in the independent variables or other aspects of the case context. A similar procedure was followed in those cases where there were no changes in the dependent variable (for instance, when an organization never made a decision to adopt a particular weapon), except that the process trace began at the end of the group's lifespan and worked backwards, constantly asking the question for each preceding time period: what antecedent factors (or the lack thereof) were responsible for the decision state *not* changing at this point? Since the antecedent causes of some dependent variables – especially leadership decisions – often cannot be established with certainty, this process also involves assessing various alternative causal paths and weighing the evidence for one against the other. Process tracing thus naturally lends itself to identifying whether equifinality characterizes the phenomenon under consideration.[18]

The next step consisted of generating a narrative for each case that provides a brief introduction to the organization, followed by a discussion of which weapons the group actually adopted (if any), or a discussion of any group involvement with the technology under consideration and a reference to other group innovations. The narrative then turns to examining the different dependent variables, one by one, marshalling evidence and providing qualitative argument for: a) whether or not the group was aware of the innovation and how this awareness may have come about; b) why the group decided to adopt or not to adopt the new technology of lethality (or failed to make the decision);

[16] The resulting matrices were extensive, most containing well over 150 rows.
[17] Van Evera, p. 64. See also, George and Bennett, pp. 206–218 and Tarrow, p. 240.
[18] George and Bennett, p. 215.

and c) reasons for the success or failure of the adoption attempt. Where there was no direct evidence to support a specific finding, inferences were made based on the available evidence and knowledge of the organization under consideration to arrive at the most likely conclusions.

Following the advice of George and Bennett and others, the process tracing was supplemented by the application of comparative methods.[19] While the procedures used will be detailed later, these consisted, first, of a direct assessment of the performance of the model hypotheses using within-case congruence testing to evaluate variations in the independent variables against observed changes in the dependent variables across time periods.[20] Since the model is probabilistic, rather than deterministic, the initial evaluation was of the model's overall predictions. This was followed by a more fine-grained analysis of the extent to which the model components (i.e., its constituent hypotheses) were supported. Lastly, elements of controlled cross-case comparison were incorporated, using both a method of difference and a method of agreement approach. The method of difference could be applied at a macro-level of factor categories, i.e. at the level of societal, ideological or organizational influences on terrorist weapons adoption, since within each pair the first two elements were held constant and the latter varied. On the other hand, the method of agreement could be appealed to, at least for the awareness variable, since most of the organizations studied over most periods share the same outcome (i.e., awareness) despite differing along many characteristics.[21] Lastly, a rudimentary counterfactual analysis was employed in evaluating the model even for those periods where a particular outcome was infeasible based on insufficient antecedents.

In addition to testing the theory (in the form of the model), many of the above techniques were also utilized to expand and refine the theory. For example, both the

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[19] According to George and Bennett, '…there is a growing consensus that the strongest means of drawing inferences from case studies is the use of a combination of within-case analysis and cross-case comparisons within a single study or research program' (p. 18). See also, Van Evera, p. 66.
[20] For a discussion of multiple congruence testing, see Van Evera, pp. 52, 58, 61; George and Bennett, p. 179.
[21] Despite several previous assertions to the contrary, Tarrow argues that neither the method of agreement nor the method of difference are intrinsically superior. Rather the preferred approach depends on the problem at hand (Tarrow, p. 235).

controlled comparisons and the process tracing could identify potentially omitted variables and help generate new hypotheses.[22]

The next two chapters each consist of two separate case narratives and qualitative analyses, followed by a chapter that applies the model to the cases and provides comparative insights.

[22] Van Evera, pp. 68-69; George and Bennett, pp. 7, 35, 209.

Chapter 6: Irish Nationalists and the Adoption of Mortar Technology

As introduced in the previous chapter, the first set of paired case studies explores the weapons adoption behaviour of the Provisional Irish Republican Army (PIRA) and the Irish National Liberation Army (INLA) with respect to mortar technology in the 1970s through the 1990s. The two groups shared a broadly common ideological and operational context – to unite Ireland and to expel the British, and their periods of operation were similar. Yet, the PIRA succeeded in adopting sophisticated improvised mortars (among a variety of other weapons), while the INLA did not even attempt to do so. Each of the cases follows the narrative structure laid out previously, beginning with a brief introduction to the organization, followed by a discussion of the mortar technology the group actually adopted (if any), or in the absence of any adoption activity, a reference to other group innovations. The narrative then turns to examining the different dependent variables, in turn discussing: a) whether or not the group was aware of the innovation and how this awareness may have come about; b) why the group decided to adopt or not to adopt the new technology of lethality (or failed to make the decision); and c) reasons for the success or failure of the adoption attempt.

Positive Case Study: The PIRA

The PIRA was viewed by its allies and adversaries alike as one of the most inventive, innovative and adaptive of all the violent non-state actors who operated in the latter part of the twentieth century.[1] Born in the sectarian cauldron of civil rights activism in Northern Ireland in the late 1960s, the PIRA emerged as a splinter group of the traditional Irish nationalist movement, breaking away from the subsequently labelled

[1] A.R. Oppenheimer, *IRA: The Bombs and the Bullets, A History of Deadly Ingenuity* (Dublin: Irish Academic Press, 2009), p. 231—'When some twenty-eight of these mortars were found in a Belfast bakery in Belfast in October 1974, the EOD officer, Lt Col John Gaff, reported that: "The equipment and ammunition are the most advanced of their type which have been used up to the present time. Much thought and care has been taken to produce it … Excellent workmanship is evident … The handwritten user instructions give the impression of past military experience of a specialized nature … although the writer does not register as having had the benefit of a high standard of education". This verdict epitomized the IRA's hallmark of improvised skills.... In just over a year, the IRA mortar had developed from something relatively primitive to an advanced weapons series'; p. 163.

‘Official’ IRA in December 1969.[2] Disagreeing with what they saw as the Marxist-leaning, overly political trajectory of the mainstream IRA (or so-called ‘Stickies’), the aims of the PIRA’s new leadership were to return to the ideological purity of using armed force to unite the six counties of Northern Ireland (which formed part of the United Kingdom) with the independent Irish Republic and to establish a socialist-oriented state in all 32 counties that make up the island.[3] Although not part of their official doctrine – which claimed to be non-sectarian – a large part of the PIRA’s ethos was also to protect the Catholic population, which formed a minority in the North, from the predations of a Protestant majority that was seen at the time to be willing to oppress and exploit their Catholic neighbours. During their almost three decades of attacks against civilians and security forces until their last ceasefire in 1998, the PIRA employed a plethora of means of murder and mayhem, ranging from small arms (most notoriously the Armalite assault rifle), to rocket-propelled grenades, surface-to-air missiles, flamethrowers, heavier machine guns (such as the M60), and an almost dizzying array of improvised explosive and incendiary devices.[4] While the following discussion will draw upon the entire breadth of PIRA innovations, especially those linked to its IEDs and their component trigger and explosive mechanisms, the focus will be on the PIRA’s development – spanning almost its entire operational lifetime – of improvised mortars as an illustrative investigation of the origins and mechanisms of the terrorist adoption of new weapons.

The Innovations

Before turning to the ‘why’ of the PIRA’s adoption of improvised mortars, it is useful to describe the ‘what’ and the ‘how’ – in other words, to outline the actual developmental trajectory of its mortar program in terms of the products that it generated and how it went about doing this. This will provide context for the decisions and processes that were involved in the adoption. In order to circumvent the need for a lengthy exposition

[2] For detailed discussions of the PIRA’s genesis, see Ed Moloney, *A Secret History of the IRA* (New York: W.W. Norton & Company Ltd., 2002), pp. 46-71; also Tim P. Coogan, *The IRA* (New York: Palgrave for St. Martin's Press, 2002), and Richard English, *Armed Struggle: The History of the IRA* (Oxford: Oxford University Press, 2003).
[3] Moloney, p. 7; Brendan O'Brien, *The Long War: The IRA and Sinn Féin* (Syracuse: Syracuse University Press, 1999), p. xiii; Brian A. Jackson, John C. Baker, et. al., ‘Provisional Irish Republican Army’, *Aptitude for Destruction Volume 2* (Santa Monica, CA: RAND Corp., 2005), p. 95.
[4] See Coogan, pp. 431-432 and Oppenheimer, *passim*, especially pp. 137, 170. Although never put into practice, the PIRA also reportedly worked on building fuel-air bombs, torpedoes, GPS-guided car bombs, and their own surface-to-air missiles (Oppenheimer, pp. xviii, 9).

of the evolution of the PIRA's mortar capability, Table 6.1[5] portrays the various generations of mortars that the PIRA developed, from its first highly hazardous and relatively ineffectual attempts in the early 1970s, to its massive 'barracks busters' of the 1990s. The table lists (where known) the year in which authorities first became aware of the type of mortar (usually the year it was first used),[6] the range and payload of each mortar, some technical aspects of its construction, prominent attacks in which it was used and additional descriptive information. It should be noted at the outset when viewing the table that the designations of the various mortar incarnations (Mark 1, Mark 2, and so forth) are labels that were applied to the various mortars by the security forces in Northern Ireland to denote what they viewed as salient changes in mortar character and function. There is thus no evidence that the PIRA leaders or engineers perceived their mortars in terms of these discrete categories – indeed, it is likely that those developing the mortars subjectively regarded the process as far more fluid and organic.[7] So long as one bears this in mind when drawing conclusions, it is nonetheless useful for purposes of clarity to retain these designations, which represent discernible technical changes in mortar construction and function.

It is immediately apparent from the table that the variety and technical adroitness that characterized the PIRA's weapons acquisition and use as a whole is mirrored in its development of mortars. Although John Horgan and Paul Gill have described the PIRA's development of mortars as an example of 'incremental innovation'[8] consisting of small improvements over previous models, this should not obscure the revolutionary nature of the program taken as a whole, nor of the numerous substantial advances that took place between individual generations of mortars, such as the introduction of an impeller-based safety system or the rapid increase in accuracy and range between 1972 and 1974. It is thus suggested that a better characterization of the process is one of a

[5] Table 6.1 is presented at the end of this chapter for formatting reasons.
[6] While it would be preferable to record the year in which the mortar was developed, this information is not available for most of the mortar types. Given that because of the nature of their struggle and the adversary that they faced, the PIRA, with few exceptions, appeared to employ new weapons relatively rapidly after they had been developed, it can be assumed that the delay between development and first use is minimal and therefore that the listed date does not egregiously distort the timeline.
[7] The mortars' designers might not have even conceived of their work as a structured 'development' process at all, rather focusing on the next project as merely an exercise in providing a weapon that met the specifications that the operational personnel desired.
[8] John Horgan and Paul Gill, *From Bomb to Bomb-Maker: A Social Network Analysis Model of the Socio-Psychological and Cultural Dynamics of the IED Process* A Report Prepared for the Office of Naval Research supported by Grant PAGEN00014-09-1-0667 (University Park, PA: International Center for the Study of Terrorism, forthcoming), pp. 1, 15. Horgan and Gill utilize the term in the sense of making small advances to current technology and repackaging existing products and behaviours in new forms.

hybrid revolutionary-incremental innovation akin to the notion of punctuated equilibrium in evolutionary systems.

With respect to the mechanisms employed to pursue development of an effective mortar capability, the PIRA almost exclusively cultivated their mortars 'in-house', mainly through their own institutional research and development (R&D) organ, the Engineering Department (ED) of the Army General Headquarters. The following are some of the major aspects of this process.

i. *Expertise*: It is unclear exactly where the expertise required for developing mortars was acquired. It is known that the PIRA drew on many talented amateurs (such as the Derry volunteers Shane Paul O'Doherty in the seventies and Patrick Flood in the eighties) who rapidly became proficient in their bomb making craft and were able to improvise extensively. It is also known that the PIRA attracted a limited number of highly-skilled technical personnel, including professional engineers.[9] With respect to weapons-specific knowledge, there is evidence of early PIRA access to military manuals of various armed forces,[10] certain members with military experience, at least some training by Libya,[11] and even indications of transfer of military knowledge from Russia and Germany during the first half of the 20th century.[12] It is thus likely that the expertise derived from a kernel of inherited knowledge that was built upon by trial-and-error, a hypothesis borne out by the intense experimentation evident during the early period of mortar development. As to the identity of the developers, directors of the Engineering Department, like Frank McGuiness[13] and Gabriel Cleary,[14]

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[9] Sean Boyne, 'Uncovering the Irish Republican Army: Organization', *Jane's Intelligence Review,* 1 August 1996. Accessed at: http://www.pbs.org/wgbh/pages/frontline/shows/ira/inside/org.html on 6 October 2013, p. 3. Later on, in the 1980s, the organization began to attract even more highly-specialized individuals, such as Richard Johnson and Eamon McGuire, who had backgrounds in electrical and aeronautical engineering (Eamon McGuire, *Enemy of the Empire: Life as an International Undercover IRA Activist* (Dublin: O'Brien Books, 2006), *passim*).
[10] Oppenheimer, p. 242; author interview with Shane Paul O'Doherty, Athlone, Republic of Ireland, 20 June 2012.
[11] Patrick Magee, one of the PIRA's best-known bomb makers, allegedly went to Libya for training in the 1970s (Oppenheimer, pp. 263, 282; author interview with Shane Paul O'Doherty).
[12] Author interview with former Northern Ireland law enforcement official 'C', Belfast, Northern Ireland, 19 June 2012. According to this source, in the early 1980s, the Garda (Irish police force) arrested a key PIRA R&D person and while in prison they uncovered details behind the PIRA's development of mortars (which remain classified), but these included references to knowledge transfer to the old IRA from the Russians and Germans.
[13] Moloney, p. 439.
[14] Sean O'Callaghan, *The Informer* (London: Corgi Books, 1999), p. 305.

probably had at least some involvement in the R&D process for mortars, while some of those individuals most closely associated with mortar development include Bernard Fox,[15] Ciarain Chambers,[16] and James 'Mortar' Monaghan.[17] It has also been revealed that for most of the period of development, the PIRA stuck with more-or-less the same full-time R&D team, as evidenced by the discovery of signature welding marks and initiation devices that were consistent across various mortars.[18]

ii. *Location*: Although organizationally centralized in the ED (with some participation from certain highly dynamic local units, especially the South Armagh Brigade[19]), there is some uncertainty as to where the actual development of mortars took place and whether this development was at a single or multiple locations. One of the former law enforcement officers interviewed for this study asserted that the PIRA had a single 'factory' responsible for producing mortars, but that the location of this factory changed from time to time.[20] Reports of Irish police raids in the early 1970s, however, suggest that there were different locations for different components, including a factory in Dublin (discovered in 1975) that fabricated firing tubes and a light engineering works in County Cavan (uncovered in 1976) where the mortar shell casings were being manufactured.[21] There are also reports that place South Armagh as a hub of mortar building and testing activity in the 1970s.[22] In 1988, the PIRA allegedly established a mortar bomb factory in Belfast itself, in the Andersonstown area,[23] and Tony Geraghty

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[15] Author interview with former Northern Ireland law enforcement official 'C'. Fox was reportedly not a trained engineer but was dedicated and quick to learn and possessed a natural knack for making things work.
[16] John Horgan and Max Taylor, 'The Provisional Irish Republican Army: Command and Functional Structure', *Terrorism and Political Violence,* 9:3 (1997), p. 14; Oppenheimer (2009), p. 281. Chambers, a Dublin-based bomb expert also known for his development of timing and power units, apparently designed later generations of mortars, including those used in the 1994 Heathrow attacks.
[17] Oppenheimer (2009), p. 99. Monaghan was responsible for the development of the Mark 15 'barrack buster' and may have been another head of the Engineering Department. He was also one of the three PIRA operatives arrested in Colombia in August 2001 and accused of transferring PIRA military expertise (including mortars) to the FARC (Cragin, et. al., pp. 71-89).
[18] Author interview with former Northern Ireland law enforcement official 'A', Belfast, Northern Ireland, 18 June 2012 and author interview with former Northern Ireland law enforcement official 'B', Belfast, Northern Ireland, 18 June 2012.
[19] Eamon Collins and Mick McGovern, *Killing Rage* (London: Granata Books, 1997), p. 257.
[20] Author interview with former Northern Ireland law enforcement official 'C'.
[21] Oppenheimer (2009), p. 170.
[22] Toby Harnden, *Bandit Country: The IRA and South Armagh* (London: Coronet Books, 2000), p. 233 cited by Jackson et. al., 'Provisional Irish Republican Army'.
[23] Martin Dillon, *The Dirty War* (New York: Routledge, 1990), p. 292.

reports that in December of the same year, the discovery of a PIRA bomb 'factory' in South London revealed items associated with the manufacture of the Mark 10 mortar, indicating that some mortar production might even have been occurring outside of Ireland.[24] One might speculate that during the initial period, mortar development took place mainly in the Republic of Ireland (and some Republican strongholds like South Armagh), but that as their production capabilities matured and the number of mortars sought increased, production locations multiplied and became more local to their places of intended use.

iii. *Explosive Components*: Explosives used as the main charge in mortars could generally be sourced from almost the entire range of the PIRA's prodigious arsenal of explosives types,[25] although lighter charges, and hence more powerful 'high' explosives, were probably preferred in most mortars to meet the exigencies of aerodynamics. Trigger, timing, and power units for the mortar systems could similarly be drawn from the extensive broader PIRA inventories and expertise in these areas.[26] The propellant used to launch the mortar was a different matter entirely. This had to be carefully formulated to achieve a safe and reliable launch, imparting a relatively steady explosive force to the mortar shell in order to ensure a consistent range. Table 6.1 traces the evolution of propellants, from early reliance on commercially available shotgun and related powder cartridges, through the J-cloth, to the more sophisticated purpose-built and precisely measured propellants that formed part of the weapon itself.

iv. *Non-Explosive Fabricated Components*: Early seizures of mortars, like that in 1974, informed the security forces that the components were being manufactured in a facility containing at least a metal lathe and heavy welding equipment, akin to a light engineering workshop.[27] The aforementioned raids of PIRA mortar production facilities in 1974 and 1975 indicated an incipient light industrial

[24] Tony Geraghty, *The Irish War: The Hidden Conflict Between the IRA and British Intelligence* (The Johns Hopkins University Press, 2000), p. 192.
[25] When supplies of commercial explosives like gelignite became scarce during the first phase of mortar development, specialist units in the PIRA focused on the manufacture of home-made explosives and developed multiple recipes, mostly based on various compounds containing ammonium nitrate fertilizer. This was supplemented in the mid-1980s by the large shipments of Semtex high explosive from Libya. See, among others, Jackson et. al., 'Provisional Irish Republican Army', p. 99 and O'Callaghan, p. 89.
[26] For an extensive discussion, see Oppenheimer (2009), Chapter X.
[27] Ibid., p. 170.

capacity,[28] which undoubtedly grew as the larger mortar models were developed to the point where Oppenheimer characterizes this capability as having a production line quality.[29] Many of the raw materials for mortar components were sourced from commercially available pipes and gas cylinders, thus minimizing the amount of machine tooling required.

Mortar development therefore primarily consisted of autarkic production, with the vast majority of components and production occurring within the organization. There is however, evidence of some elements of external patronage in the initial sources of knowledge and training and of exploitation of existing networks in the use of widely available legitimate products as the basic raw materials for mortars.

Before proceeding, in order to make the subsequent analysis of the model tractable, it is necessary to partition the period of PIRA organizational history into a limited number of phases between which there are more substantive differences than within. At the same time, since there are many important developmental episodes within the PIRA's long history, any such separation into a number of phases that is small enough to analyse practically is bound to appear somewhat arbitrary and will elicit protest from one or the other expert. The choice of partition was therefore made with two guiding criteria: a) that different phases at least contain different organizational, political and operational characteristics from each other; and b) that the phases represent, to the extent possible, different stages of mortar development, with the objective being to examine how the model fares under different circumstances amongst its input and dependent variables. While remaining aware of the perils of reductionism, upon reviewing the operational history of the PIRA, it can be usefully categorized according to the following four phases:

1. *Lack of Mortar Capability* (1969 to 1971): This period coincides with the formative years of the PIRA, from its inception until the end of 1971. In keeping with the general paucity of 'gear' during the first few years of the PIRA's existence, and the crudeness of the organization's attempts to improvise

[28] Ibid.
[29] Author interview with Andy Oppenheimer, London, England, 22 June 2012.

weaponry during this period, the PIRA lacked any appreciable capability to deliver mortars or similar stand-off projectiles.

2. *Intense Experimentation* (1972 to 1974): The second phase begins with Bloody Sunday and the imposition of Home Rule and extends until the end of 1974, shortly before the beginning of the ceasefire of that year. While these were not always (or even often) effective, this phase consisted of a rapid succession of attempts to obtain a reliable mortar weapon, culminating in the successful production of the relatively effective Mark 6 mortar in 1974.
3. *Approaching Military Grade* (1975 to 1987): The third phase contains the ill-fated 1975-1976 ceasefire, the acceptance by the PIRA of the 'Long War' strategy, the prison protests and the 1977 reorganization into Active Service Units (ASUs). It also witnessed some missteps with respect to mortar development (the Mark 8), but a steady improvement towards the deadly effective Mark 10 (first used in 1979).
4. *Bigger and Better* (1988-1998): This phase begins with the interdiction of the *MV Eksund* at the end of 1987 and traces the consequences for mortar development of the receipt of large quantities of Semtex high explosive from Libya in the mid-1980s. The fourth phase took the PIRA's mortar capabilities in new directions, both with respect to size – culminating in the 'barracks busters' – and in versatility, for example, with man-portable versions (Marks 12 and 16).

We can now turn to examining, *seriatim*, the core questions posed by this study.

Innovation Awareness

This question pertains to the initial awareness of mortars as a possible weapon and is thus mostly relevant to the first phase of mortar development. There is no direct evidence of how the PIRA first became aware of the possibility of acquiring or producing improvised mortars, but the circumstantial evidence points towards this awareness resulting from an active search in order to address a specific performance requirement. In the early days of the PIRA's campaign, the organization experienced a dearth of weapons of any kind, least of all those that could have a measurable impact on their well-equipped adversaries in the Royal Ulster Constabulary (RUC), Ulster Defence Regiment (UDR) and the British Army. According to Coogan, 'It is literally true, for instance, that in August 1969 the only weapons known to be available to the IRA were ten guns'.[30] At its inception, PIRA volunteers could thus do little more than riot and throw petrol bombs.[31] The situation, from the Provisionals' point of view, began to improve with the importation of guns from the United States and elsewhere and the acquisition of commercial explosives, but very soon they recognized the need for stand-off weapons, i.e. weapons that could be fired from a safe distance, while minimizing the risk of detection for the attackers.[32] The development of new trigger and detonating mechanisms for explosives (including command wires and timers) solved many of these problems, but the Provisionals were confronted by a new challenge when many of its prime targets in Northern Ireland, police stations and barracks, began to be heavily fortified in the early 1970s.[33] This required a different kind of stand-off weapon, one that could breach fortifications that might not always be vulnerable to a pre-planted bomb. Initial attempts to circumvent these defences consisted of catapulting petrol bombs from nearby roofs and subsequently what is referred to as a 'spigot grenade',[34] a container of explosive with a lit fuse attached to the end of a dowel rod, which was fired from a bow or shotgun. Needless to say, both of these approaches left a lot to be desired in terms of safety and reliability and alternatives were sought.[35]

It was at this stage that the obvious possibility of using mortars must have occurred to one or more members of the PIRA. By the mid-20th century, mortars were a fairly standard complement in armies worldwide, having proven their utility over traditional artillery in terms of reaching over all kinds of obstacles, from redoubts on hilltops to foxholes in the trenches of World War I. While many of those who flocked to the fledgling movement were young people caught up in the activism of the late 1960s, there were also a handful of older PIRA members, including those with military

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[30] Coogan, p. 367; See also English, p. 115 for a similar sentiment.
[31] Gerry Bradley and Brian Feeney, *Insider: Gerry Bradley's Life in the IRA* (Dublin: The O'Brien Press, Ltd., 2009), p. 60. The lack of military capability extended also to the availability of personnel with the requisite *mētis*, perhaps best illustrated by the fact that Jack McCabe, the incipient PIRA Quartermaster General and chief bomb maker, blew himself up when his mixing explosives with a shovel gave off a spark (Coogan, p. 367).
[32] Oppenheimer (2009), p. 228. Initially, many of the PIRA's attacks took place in decidedly close proximity to their adversaries, for example, engaging troops at close range with pistols or throwing hand-held nail bombs (Shane Paul O'Doherty, *The Volunteer: A Former IRA Man's True Story,* (Durham, CT: Strategic Books Group, 2011), pp. 60-61; Jackson et. al., 'Provisional Irish Republican Army', p. 100), practices which do not bode well for the continued availability of large numbers of personnel for a protracted struggle.
[33] Oppenheimer (2009), p. 229.
[34] Ibid., pp. 228-229.
[35] Ibid, p. 229.

experience in World War II or elsewhere. Some of these old hands had no doubt used or at least encountered mortars and were thus equipped to identify the mortar as the ideal weapon to solve the problem of fortified targets. This would make the mechanism of awareness, in terms of the earlier theoretical discussion, a combination of active searching and prior demonstration. Even without men with prior military knowledge, it is known that the young, brash volunteers with only street battles under their belt consulted military manuals looking for ideas on using explosives,[36] providing yet another avenue for awareness of the mortar as a possible useful acquisition to the PIRA's burgeoning arsenal.

The Adoption Decision

People and Process

Prior to confronting the actual decision surrounding pursuit of the ongoing development of improvised mortars, it is necessary to identify the probable decision makers and the decision context in which a decision of this type was likely to be made. Organizationally, the PIRA was something of a hybrid. On the one hand, at the time of its split with the Officials, the PIRA theoretically inherited the well-defined, traditional structure of Irish Republican militants, modelled somewhat ironically on the British Army.[37] On a daily basis, supreme authority rested in the Army Council – elected by the General Army Convention through an Army Executive – which directed a General Headquarters (GHQ) consisting of ten specialist departments. At an operational level, the Army was for its first decade divided into brigades and battalions, but after 1978 it was split for political and security reasons into Northern and Southern Commands, with the Northern Command presiding over brigades that were more cellular in nature[38] and consisted of four to eight person Active Service Units (ASUs).[39] On the other hand, in practice, while overall strategy was laid out by the Army Council, operational control was far more decentralized. Local units (at least down to the brigade level and

[36] Author interview with Shane Paul O'Doherty. Jackson et. al., 'Provisional Irish Republican Army', p. 121, citing O'Callaghan.
[37] English, p. 114 and Coogan, p. 379.
[38] For more detailed information on this structure, see Horgan and Taylor, *passim*; Moloney, pp. 376-379.
[39] Moloney, pp. 157-160; Coogan, p. 465; M.L.R. Smith, *Fighting for Ireland?: The Military Strategy of the Irish Republican Movement* (London: Routledge, 1995), p. 188.

sometimes even to the level of individual ASUs) enjoyed a high degree of autonomy in such factors as targeting and weapons employment.[40] This was true even in the early years, as former PIRA bomb-maker Shane Paul O'Doherty describes: 'it was largely up to the local talent to design, develop, and agree to use a new technology'.[41] Therefore, the PIRA exhibited both top-down and bottom-up decision-making.[42]

Yet, it has been asserted that in the case of a decision of the magnitude of whether or not to embark on a major enterprise like the acquisition or development of mortars, the decision would take place at the centre of the organization.[43] In fact, O'Doherty specifically mentions the development of mortars as one of the few decisions that was centralized during his tenure with the organization in the early 1970s.[44] It is therefore extremely probable that the final decision regarding whether or not to acquire mortars, and whether to embark on an indigenous development program, would rest with the Army Council. In the absence of access to internal Army Council documents, it is difficult to state with certainty which members of the Council might have been for or against the adoption of mortar weapons technology, but of the original tranche of PIRA leaders it has been reported that David O'Connell was a keen proponent of the Provisionals' use of the then-novel car bomb,[45] so he might very well have been among the supporters of an instrumentally useful weapon like mortar systems.

It is quite unlikely, however, that the Army Council would make a decision to adopt mortars without some input from below. The most probable sources of such input would be the department of the Quartermaster General (QMG) and the Engineering Department. While the QMG would presumably have a greater say in the case of externally acquired mortar systems and the Engineering Department would predominate in discussions of internally developed mortars, both departments would likely be

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[40] Horgan and Taylor, p. 23; Dillon, p. 153; Kevin Toolis, *Rebel Hearts: Journeys Within the IRA's Soul* (New York: St. Martin's Press, 1995), p. 319. All in all, Boyne ('Uncovering the Irish Republican Army: Organization') argued in 1996 that the core middle-ranking operational decision makers in the PIRA numbered approximately 40 individuals.
[41] Author interview with Shane Paul O'Doherty. Also see, O'Doherty, *The Volunteer*, pp. 120-124. This independence of action was heightened in the wake of the 1978 reorganization (Jackson et. al., 'Provisional Irish Republican Army', p. 134).
[42] Author interview with former Northern Ireland law enforcement official 'A'.
[43] Author interview with former Northern Ireland law enforcement official 'D', Belfast, Northern Ireland, 19 June 2012.
[44] Author interview with Shane Paul O'Doherty.
[45] English, p. 111.

heavily involved in providing guidance and expert opinion to the Army Council (especially since the QMG usually sat on the Army Council itself).

This somewhat bidirectional nature of decision making within the PIRA has been confirmed by a former law enforcement official familiar with PIRA command and control as being the most probable operationalization of the mortar adoption decision. In this dynamic, bottom-up requirements and suggestions would filter up through the hierarchy to the Army Council from local units, and technical assessments of the feasibility of the endeavour would be given by those with expertise in GHQ (especially the Quartermaster and Engineering Departments).[46] The Army Council would then make the final decision in a top-down fashion and implement it through the Chief of Staff and GHQ.[47] Richard English has singled out the PIRA's somewhat flexible command and decision making structure – the 'combination of high-level centralization with locally autonomous initiative' – as playing an important role in the PIRA's constant efforts to innovate.[48]

Turning to the actual mortar adoption decision, this can be divided into three component decisions: a) the initial decision whether to acquire mortars or not; b) the decision regarding which mechanism of adoption to employ; and c) the subsequent series of decisions to continue with the development of mortars beyond the first successful attempts.[49]

Initial Adoption

The initial impetus for considering mortars has already been introduced. To anyone familiar with weapons at the time, mortars were a logical choice in order to overcome the physical hardening occurring around the PIRA's favoured target facilities, such as police stations, which usually consisted of stronger perimeter fortifications but left the roofs of the facilities relatively unprotected. In other words, the PIRA were driven to

[46] Author interview with former Northern Ireland law enforcement official 'A'.
[47] Author interview with former Northern Ireland law enforcement officials 'A' and 'D'.
[48] Richard English, 'The IRA's Attempted Murder of Prime Minister Margaret Thatcher', in Rasmussen and Hafez (eds.), p. 119.
[49] The last component is not strictly necessary, since it is conceivable that the IRA could merely have continued to develop new mortar weapons based on an institutional inertia, as has been argued to have occurred with certain other elements of their explosives development. The third decision element might thus more accurately (if awkwardly) be recast as: 'the absence of a decision to cease mortar development'.

seek mortars by a tactical need.[50] This echoed a range of other cases of PIRA weapons and technology adoption, from its use of long-delay timers in Brighton in 1984 to overcome security sweeps, to its adoption of shaped explosives charges to penetrate armour.[51] The fact that mortars also provided a standoff capability that would help shield their operators from detection was another feature making them attractive to the PIRA.[52] Conversely, the high ballistic arc of a mortar made it possible to fire on targets fairly close to the launcher (at least when measured relative to other forms of artillery) – or even above it – which at times could be useful in built-up urban environments.[53] Some PIRA commanders might also have believed that using mortars against police and military bases would deflect security force attention away from Catholic areas and the PIRA.[54]

Yet, all these benefits do not guarantee that an organization would choose to adopt mortars. One needs to consider the costs as well as the benefits, in addition to an actor's perception of the likelihood of success. After all, there is evidence that the PIRA's penchant for innovation – at least in its early years – was not as widespread or unequivocal as it later seemed to be. Shane Paul O'Doherty, for instance, describes a time in the early 1970s when his commanders were extremely sceptical about the technologies that the new crop of volunteers were presenting them with and their conservatism led them to favour the simplest methods possible.[55]

There must also be some consideration of the available alternatives. The security countermeasures installed by the British could conceivably have been dealt with in other

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[50] Author interview with former Northern Ireland law enforcement official 'A'. See also, Jon Coaffee, 'Rings of Steel, Rings of Concrete and Rings of Confidence: Designing Out Terrorism in Central London Pre and Post September 11th', *International Journal of Urban and Regional Research*, 28:1 (2004), pp. 201–211. This was yet another example of where, 'Above all, necessity – and the constant need to improvise, usually in covert and haphazard conditions – was the mother of IRA invention' (Oppenheimer (2009), p. xx).

[51] See Brian Jackson, Peter Chalk, et. al., *Breaching the Fortress Wall: Understanding Terrorist Efforts to Overcome Defensive Technologies* (Santa Monica, CA: RAND Corp., 2007), p. 101. Oppenheimer (2009, pp. 209-210) discusses the 'race' up and down the electromagnetic spectrum between the PIRA and the security forces in terms of attempts to jam detonation signals.

[52] Personal correspondence with Dr. Brian Jackson, RAND, 16 May 2012.

[53] See Oppenheimer (2009), p. 228 for a similar idea.

[54] Keith Craig and Ian Geldard (*IRA, INLA: Foreign Support and International Connections* (Institute for the Study of Terrorism, 1988), p. 99) assert that this was one objective of the larger PIRA bombing campaign, but they regard such ideas as misguided and ultimately counterproductive.

[55] O'Doherty was even referred to by some of the old guard as 'the font of useless knowledge'. On one occasion he devised a novel safety mechanism whereby a detonator could be separated by a tube from the explosive prior to arming the explosive, but it was rejected with an 'if it ain't broke don't fix it' attitude. Author interview with Shane Paul O'Doherty.

ways,[56] such as shifting to different targets, infiltrating facilities, building bigger bombs or finding simpler methods of getting bombs over the walls.[57] Upon closer inspection, however, none of these alternatives were really open to the PIRA of the early 1970s. Target shifting was not an attractive option – the Provisionals were already going hell for leather in terms of trying to bring commercial activity in the North to a standstill through bombing city centres in towns like Derry and Belfast and, at least in Northern Ireland, the PIRA did not want to be seen to intentionally target civilians.[58] Allowing the other focus of their operations – Northern Ireland and British security forces – to retreat to the safety of their bases was not a viable option under the PIRA's strategy of the time.[59] Furthermore, while their bomb-making was becoming more proficient and they were embarking on the production of home-made explosives, the days of the 'city destroyer' bombs of the 1990s were far off and it is doubtful whether the organization could have developed explosive devices big enough – and stationed them close enough – to blast their way through the fortifications. Last, simpler methods had failed to show much promise: O'Doherty's flare bombs (see Table 6.1) were insufficient to cause much damage, the spigot grenades were too dangerous, and hijacking aircraft to drop bombs on the roofs of police stations was impractical on a large scale.[60]

When one takes into account the operational benefits of mortars, together with the desire of the PIRA at the time to attack the security forces in particular and the absence of viable alternatives, there is a strong rational argument for the pursuit of mortar capability, despite the anticipated costs. In the absence of any countervailing

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[56] For an extensive discussion of terrorist adaptations to countermeasures see Jackson, et. al. (2007), *Breaching the Fortress Wall*.
[57] One former law enforcement official remarked that, as well as moving to high-technology solutions, the PIRA occasionally moved towards old, tried and true technology to overcome problems (Author interview with former Northern Ireland law enforcement official 'C').
[58] Jackson et. al., 'Provisional Irish Republican Army', p. 212. Because the PIRA wanted to appear to be a legitimate military organization, it had a stated goal of minimizing civilian casualties in its operations. The PIRA's commitment to this as a criterion of success differed over the course of its operational history, however, and its actual (in contrast to verbal) commitment to it has been disputed. Use of this as a criterion also differed among the PIRA's theatres of operation (J.M. Glover, *Northern Ireland Terrorist Trends* (London: Ministry of Defence, British Government, 1978) and Horgan and Taylor).
[59] Jackson et. al., 'Provisional Irish Republican Army', p. 212. Because of the focus of its actions in Northern Ireland, the PIRA used the damage it inflicted on the security forces as a measure of success. Indeed, the group saw this as directly connected to its overall goal: '[Reportedly] . . . the Army Council set an initial target to kill thirty-six British soldiers because it was thought that this figure matched the number of troops killed in Aden and would supposedly impose enough pressure on the British to oblige them to negotiate' (Smith, p. 97).
[60] O'Doherty recounts an episode when he volunteered to go up in a helicopter to investigate whether it would be possible for explosives to be dropped on Strabane police station (author interview with Shane Paul O'Doherty).

indications, it appears as if this, or a similar (albeit less formal) calculation, is the most likely result of Army Council deliberations on the issue of the PIRA adopting an organizational mortar capability. A comparable logic might prevail in other cases of PIRA weapons adoption, but that remains an empirical question.

Autarky as the Preferred Mechanism of Adoption

We have seen that the PIRA followed the path of internal development using its own resources and expertise, i.e., it engaged in autarkic adoption of mortars. There are several mutually reinforcing arguments for how this decision was reached:

i. *Expense and Security Risks of External Adoption:* The PIRA sourced many of its weapons through patronage (primarily through the largesse of Libya's Moammar Gaddafi and Irish-American sympathizers in the United States)[61] and exploitation (such as purchasing arms from third party suppliers or stealing detonators from commercial quarries), but these sources presented certain disadvantages for more sophisticated weapons like mortars. First of all, the basic purchase of weapons systems on the open market can be expensive, and can open the organization's activities up to interdiction or infiltration by security forces which can simply monitor known arms suppliers, not to mention the additional resource costs and risks associated with transporting, storing and maintaining purchased arms.[62] While the IRA had a steady funding stream for most of its existence, especially in the early years this funding was limited. Moreover, several of the organization's attempts to import arms, whether from purchases or overseas patrons, were interdicted in the 1970s and 1980s, with notable examples being seizures of weapons at Schipol Airport (1971)[63] and on the ships, the *Claudia* (1973),[64] the *Marita Ann* (1984)[65] and the *Eksund* (1987).[66] Some reports list mortars among the seized weapons,[67] but it can be inferred that, while the organization's officers might have attempted to include externally-sourced mortars in large arms consignments at various times,

[61] Moloney, pp. 8-12; Dillon, p. 396; Bradley and Feeney, p. 96.
[62] Oppenheimer (2009), p. 150.
[63] Coogan, p. 432.
[64] Craig and Geldard, p. 72.
[65] Toolis, p. 67.
[66] Maloney, pp. 3-8.
[67] Ibid., p. 171 and Dillon, p. 399, for example, mention mortars amongst the weapons seized by Belgian customs officers in 1977.

these attempts were not successful, since this type of mortar was never used by the PIRA. Furthermore, a former law enforcement official has stated that the PIRA never procured commercially available mortars.[68] Possessing an internal production capability would obviate many of these risks, because large numbers of mortars did not need to be stored, but could be manufactured as needed. Also, any interdictions of mortars would not negate the knowledge of how to build new ones in the future,[69] and necessary components could be purchased legitimately – and more cheaply – than military mortars.[70] O'Doherty maintains that most R&D was generally conducted from within the organization because of a reluctance to be dependent on a potentially fickle external supply. He gives the example of detonators as an item where interruptions in the external supply at the end of 1973 and beginning of 1974 in Derry severely curtailed PIRA operations in the area.[71]

ii. *Specific Tactical Requirements:* The PIRA had usage requirements that differed substantially from military mortars. While military mortars were designed for fairly long ranges (~5,000m), to have the firer present upon launch and to be used numerous times, the nature of the PIRA's covert terrorist campaign meant that it required mortars operative over shorter ranges (within the confines of a city), with options to fire remotely and where the launcher was generally abandoned after a single use.[72] Moreover, military mortars required expertise and practice to aim correctly and achieve desired accuracy; the PIRA volunteers launching mortars from the back of a van and aiming in the general direction of a police station were operating under different functional constraints.[73] Producing their own mortars would thus allow the PIRA to customize weapons for their own purposes.

iii. *Deficit of Trust in Externally Sourced Materials:* As the conflict in Northern Ireland wore on, there were increasing cases of British or RUC counterintelligence personnel 'doctoring' or otherwise sabotaging PIRA weapons – including guns with

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[68] Author interview with former Northern Ireland law enforcement official 'B'.
[69] Personal correspondence with Dr. Brian Jackson.
[70] Oppenheimer (2009), p. 150.
[71] Author interview with Shane Paul O'Doherty. As further support for this thesis, the PIRA was even prepared at one stage to undertake the extremely hazardous task of trying to produce its own detonators in order to ensure a reliable supply, as uncovered during the Kilcock raid in 1993 (Oppenheimer (2009), p. 204).
[72] Author interview with former Northern Ireland law enforcement official 'A'.
[73] Ibid. One former law enforcement official mentioned that PIRA mortar operators would merely aim for the tall radio masts that formed part of the police station or military complex.

built-in surveillance devices or explosives that would not detonate.[74] This led to PIRA engineers having decreased confidence in externally-sourced materiel and provided an additional impetus to produce those weapons internally when it could.

iv. *DIY Prestige:* In addition to the purely tactical advantages of particular weapons, there were also the symbolic messages that would be tacitly conveyed by the use of a particularly sophisticated weapon. It is reported that at all levels of the IRA, from the organization as a whole to individual units, there was often the desire to show various audiences, whether it was the British, the Catholic constituency or even other brigades in the PIRA, how ingenious, capable and terrifying the PIRA could be. As Oppenheimer contends, 'doing-it-yourself was and still is irreplaceable as a sign of prestige'[75] – an indigenous mortar capability would bestow propaganda benefits on its developers.

v. *Technical Confidence and Constituencies*: With the exception perhaps of the LTTE, the PIRA possessed the most mature, highly-skilled and productive research and development organ in the annals of violent non-state organizations, the so-called Engineering Department (ED). The ED's committed and cunning senior technicians were responsible for numerous breakthroughs in the arts and instruments of clandestine war against the state and enjoyed a substantial level of influence as the PIRA's elite.[76] Their early successes with explosives mixtures in the 1970s (following the initial missteps in this regard) might have given them (and the PIRA's senior command) the confidence that they could take on the difficult task of developing an effective mortar capability. Even if this confidence was lacking among members of the Army Council or other senior leadership, the ED enjoyed a degree of independence from frontline operations,[77] and the decision to engage in the development and production of mortars may have been the PIRA leadership's way of 'letting the movement's better technical intellects have their experiments'.[78] The subsequent history of the organization certainly presents many examples of

[74] See Dillon, p. 229 for examples.
[75] Oppenheimer (2009), p. 257.
[76] Horgan and Taylor, p. 14.
[77] Oppenheimer (2009), p. 280.
[78] Mark Urban, *Big Boys' Rules: The Secret Struggle Against the IRA* (London: Faber & Faber, 1992), p. 210.

highly educated and skilled individuals being given more or less free rein to develop or acquire new weapons technologies.[79]

vi. *Weapon Evolution*: Indigenous development allowed for the PIRA's mortar capability to evolve over time, and adapt to new requirements and developments, whereas if mortars were externally sourced, a new product would have to be identified, possibly necessitating the development of a relationship with a different supplier and the locating of new transport channels. In-house production would allow for incremental, as well as discontinuous, development, as required,[80] a benefit that would not be lost on forward-thinking leaders.

Impetus for Sustained Development

Even after the initial decision to engage in the production of mortars (during the Lack of Capabilities phase), the question remains as to why the PIRA persisted through three more phases, even substantially expanding the breadth of their R&D program in the Approaching Military Grade and Bigger and Better phases. One of the obvious reasons why the development of mortars continued past the initial versions (Marks 1 and 2), is the set of drawbacks associated with these somewhat stumbling first steps – both in terms of the mortars' effectiveness as weapons and the risk posed to their handlers (see Table 6.1). It was to be expected that the developers would continue for some time until they 'got it right'. Perhaps a more interesting question is why there were another eleven models after the Mark 6, which was sufficiently reliable to be utilized in the high-profile 1994 attack on Heathrow Airport twenty years after it was first deployed. At least part of the answer might be found in the momentum that develops behind many long-term development programs that are at least partially insulated from interference by the leadership or enemy forces – members of the ED revelling in their technical prowess may have been loath to cease working on a challenging system that attracted a large amount of external attention to the movement. However, there were doubtless external in addition to organizational drivers of continued development. We have stated above

[79] One of the more well-known examples is that of the so-called 'Boston Three' (actually five scientists, including an aeronautical engineer, a computer scientist and someone with high-level U.S. security clearance) who set about developing a guided missile system in the United States with the aim of being able to shoot down British aircraft (primarily helicopters) in Northern Ireland – see McGuire, pp. 211-212; 25.

[80] Personal correspondence with Dr. Brian Jackson.

that offence and defence in general establish a co-evolutionary dynamic that, from the PIRA's point of view, forced their 'mortar offence' to constantly adapt and grow in order to cope with more robust defences, or in Oppenheimer's words, 'to keep the authorities on the hop'.[81] Larger, more penetrating mortars were required, for instance, by further British hardening of military structures specifically against mortars in the 1980s, including an empty top floor and a reinforced roof.[82] Desensitization of the media, the enemy and a group's constituencies from multiple uses of the same weapon – some mortars were used hundreds of times – might also drive the leadership to demand something new.

The evolution in mortars should be seen in the context of the broader improvements made by the PIRA in improvised explosive devices (IEDs) over the 1970s and 1980s. In many ways, the development of mortars mirrored the early PIRA bombs, which had begun with a barrage of inchoate, often dangerous and counterproductive explosive devices in the early 1970s and grew to a more sophisticated, diverse, targetable and reliable set of explosive tools by the late 1980s.[83] As a last note, although there were public outcries at particular mortar attacks (especially when the mortars went awry and harmed civilians), there does not appear to have been any specific rancour directed towards the mortar as a particular tactic, as there was with letter bombs and later 'human proxy' bombings, which had forced the PIRA to cease or minimize these practices.

Factors Responsible for the Success of Adoption Efforts

When it comes to judging the success of the PIRA's adoption efforts,[84] it is apparent from Table 6.1 that the PIRA did, by the end of the second phase in the development process and barely two years after its first tentative attempts,[85] succeed in producing a reasonably reliable and safe weapon that at least some of the time resulted in physical damage and casualties, thus achieving a minimal level of success. Further, by the

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[81] Oppenheimer (2009), p. 292.
[82] Urban, p. 207; Geraghty, p. 94. Jackson, et. al., refer to terrorist behaviour in this context as 'escalating' – Jackson et. al,(2007), *Breaching the Fortress Wall*, p. 100.
[83] See Oppenheimer (2009), p. 256, for a similar but not identical notion.
[84] Here we are focusing on success in the actual adoption process, rather than the efficacy of mortars in advancing the PIRA's long-term political and strategic objectives.
[85] The interval between the appearance of the Mark 1 mortar (1972) and the far more effective Mark 6 (1974).

middle of the 1990s, PIRA mortars were evaluated as comparable in quality to military models.[86]

However, this broad picture elides to some degree the difficulties and setbacks experienced on the road to developing a robust capability, which can also be gleaned from a close look at Table 6.1. The accuracy of many of the models was poor, not only of the earlier attempts, but sometimes (as with the Marks 7, 8, and 9) accuracy was intentionally traded for greater explosive power. Such development choices are inconsistent with the PIRA's avowed desire to avoid civilian casualties in Northern Ireland, signalling either gross incompetence and negligence, or belying the claim of civilian immunity from attack. The inclusion of shrapnel such as ball bearings or pennies in certain mortar shells seems to favour the latter explanation.

Another major problem was the safety of the devices. Many of the explosives used were volatile and the designers did not include safety mechanisms in at least the first five variants, resulting in 'own goals', such as the death of two PIRA volunteers from the premature explosion of a Mark 3 mortar in 1973.[87] Compounding safety and accuracy issues was a lack of detonation reliability – many of the mortars, even if they did not blow up on launch or hit the wrong target, failed to detonate upon impacting the intended target.

It is little surprise, therefore, that from a purely military utilitarian point of view (putting aside psychological or propaganda effects), the effectiveness of many of the mortars – even the relatively more reliable ones – left a lot to be desired. From 1973 to 1978, for example, the PIRA attempted 71 attacks with mortars, without inflicting any adversary fatalities.[88] Between 1981 and 1992, even a publication sympathetic to the PIRA revealed that 15% of 92 mortar attacks experienced technical glitches such as missing the target or exploding improperly or not at all, with a further 35% of attacks resulting in no reported casualties.[89] Again we see the behaviour of mortars closely tracking that

[86] Geraghty, p. 190.
[87] O'Callaghan, pp. 84-85. This to some extent paralleled the wider safety issues that the PIRA was having at the time when it came to dealing with explosives. For example, in June 1970 much of Derry's PIRA leadership (together with two children) were killed while constructing bombs in a kitchen (Toolis, p. 304).
[88] Oppenheimer (2009), p. 230.
[89] *IRIS: The Republican Magazine* incident reports between 1981 and 1992, figures cited in personal correspondence with Dr. Brian Jackson, RAND.

of the PIRA's weapons overall – it has been reported that through the 1980s and early 1990s, 90% of PIRA operations failed or were called off, although it must be acknowledged that not all of these occurrences were due to technical failures.[90]

Nonetheless, the PIRA's technicians persevered with the development of mortars and were eventually successful in addressing many of the problems of safety and reliability through a number of ingenious advances, from impeller-operated arming mechanisms to sophisticated timers and triggers. Although accuracy presented a perennial problem, even this improved markedly. For example, according to a former Northern Ireland law enforcement official, in the 1985 attack on the Newry Police Station the landing locations of the several mortars used were closely grouped, indicating a fair amount of accuracy and reliability in ballistic trajectory.[91]

These achievements were all the more remarkable when one considers that over the entire period of development, the PIRA was under intense security pressures, including surveillance, infiltration by informers and concerted efforts by British and Irish authorities to interdict or uncover their weapons supplies and facilities. On an operational level, their use of mortars was circumscribed by the lack of opportunity to do ranging shots and to remain in place long enough to adjust their aim before trying again – most mortars were either worked remotely or were of the one-time, 'fire and forget' variety. PIRA volunteers came up with creative workarounds, including doing practice runs in remote locations and firing from mobile platforms (e.g., through the cut-out roofs of vans or building equipment).[92]

Most importantly for measuring success, the PIRA did launch several mortar attacks that caused serious injuries or fatalities and some that qualified as 'spectaculars'.[93] Among the more notable mortar attacks were:

a) *Newry Police Station* (February 28, 1985): The local unit and South Armagh volunteers launched nine Mark 10 mortar shells from a hijacked truck aimed at

[90] Oppenheimer (2009), p. 84; Smith, p. 177, reports figures of eight aborted or failed attacks of eighteen between February and May 1983, which equates to a failure rate of 44%.
[91] Author interview with former Northern Ireland law enforcement official 'B'.
[92] Harnden, pp. 233-234, cited in personal correspondence with Dr. Brian Jackson, RAND, 5/16/2012.
[93] Although never causing nearly the scope of death and destruction as the so-called 'city buster' bombs in London and Manchester in the 1990s, the Downing Street and Heathrow mortar attacks were notorious more for the nature of the target than anything else.

the RUC station in Corry Square, Newry. Eight shells overshot the station, but one landed on a canteen, killing 9 policemen and injuring 37 other people.[94]

b) *Downing Street Attacks* (February 7, 1991): During British Cabinet deliberations regarding the Gulf War, the PIRA fired three Mark 10 mortars from a specially-constructed opening in a van parked near Downing Street, central London. One mortar hit a tree and detonated several metres short of its target, shattering the blast windows in the Cabinet Room, forming a wide crater in the gardens and severely damaging Nos. 11 and 12 Downing Street. The other two shells did not explode and were rendered safe.[95] According to a law enforcement source familiar with the attack, the mortars were actually quite accurate – the only reason they missed the target was that the ranging mark on the pavement that the attack team had made the previous day had been washed away by snow and the team had to estimate its position on the day of the attack, resulting in a few metres' discrepancy.[96] Had this intervention by Mother Nature not occurred, there might very well have been a direct hit on the Cabinet.

c) *Heathrow Airport Attacks* (March 8, 10 and 13, 1994): A PIRA team fired three separate salvos of 4-5 Mark 6 mortars at Heathrow Airport's northern runway and Terminal Four building. One bomb landed on the roof of Terminal Four, which had approximately 4,000 occupants at the time. None of the mortars exploded, perhaps because the PIRA had not intended them to, but one widely-held opinion is that they had been sabotaged by security forces or an informer.[97] Nonetheless, the targeting of a facility in which a successful attack could have caused thousands of civilian casualties represented one of the most ambitious attacks by the PIRA up to this time and the fact that a second and third attack were possible despite increased security caused embarrassment for authorities.[98]

Irrespective of casualties, all of these attacks had substantial psychological impact (the *raison d'être* of genuine terrorism). This, together with the casualties that were caused

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[94] One of the former law enforcement officials remarked to the author that, although the accuracy was reasonable, the attack was not quite as successful as often reported, since only one of the eight mortars detonated. Author interview with former Northern Ireland law enforcement official 'C'.

[95] Andy Oppenheimer, *30 Years of IEDs: The Operational Art of the Provisional IRA*, PIRA – Lessons Learned Conference (Stockholm: Swedish National Defence College, 17 April 2012).

[96] Author interview with former Northern Ireland law enforcement official 'B'.

[97] Moloney, p. 424.

[98] Oppenheimer (2009), p. 232. The mortars had been concealed underground and were fired from an area close to the perimeter fence.

and the drastic improvements in the weapons themselves lends weight to a conclusion that, as a whole, the PIRA successfully adopted the weapons technology of mortar systems.

It remains to identify some of the contributing factors to this success. After a thorough analysis of the context surrounding the PIRA's development of mortars, three interrelated factors stand out as most salient.

Organizational and Individual Expertise and Access

The PIRA inherited a lot of latent knowledge from before the 1969 split,[99] including the basics of explosives and some long-standing relationships with foreign supporters (such as in the United States). It also had an organizational model that its members were comfortable with and that had served them reasonably well in the past. This meant that the organization did not have to start from scratch, so to speak, either technically or organizationally and, although it was strapped for weapons and other resources in 1970, it was able to build on its legacy capabilities to quickly reconstitute its expertise and access to resources. In addition, the socio-economic background of its membership ended up serving it well in the area of weapons development. The majority of its members were working-class Catholics, who while not necessarily possessing the *techne* for weapons development, brought with them a basic inventiveness, creativity and 'working men's skillsets' like machining and welding. In addition to the direct value of such experience in the fabrication of mortars, this background quickly allowed the organization to develop a high level of practical *mētis* – something that was essential for solving the obstacles encountered in developing improvised weapons. At the same time, the appeal of the PIRA was sufficiently broad that the organization was able to attract the services of a small number of highly-trained individuals, including engineers, chemists and computer scientists to provide the requisite knowledge of aerodynamics, timing systems and so forth – in other words the right *techne* to build a mortar capability.[100] Perhaps the best example of this is the fascinating story of Eamon McGuire, an aeronautical engineer, who, while not a full-time member of the

[99] Author interview with Jim Cusack, Dublin, Republic of Ireland, 20 June 2012.
[100] An interesting case occurred when the PIRA identified and recruited a British Telecom engineer with Republican leanings. Counterterrorism officials were able to identify his origins from the fact that he used a method for fastening wires that was characteristic of British Telecom training. Author interview with former Northern Ireland law enforcement official 'A'.

organization, devoted years of service to identifying, acquiring and developing new technologies for the Provisionals, including assisting them in their electromagnetic cat-and-mouse games with British radio signal jammers and his participation in the abortive attempt to produce an indigenous surface-to-air missile for the PIRA.[101] Agents like McGuire – who ended up on the run from the FBI for several years in a chase that spanned the globe before spending substantial time in the US prison system – were able to acquire necessary technical equipment and knowledge.[102]

At the same time, there was an organizational structure that was set up to promote and implement innovation from the very beginning. The embodiment of this institutionalization of R&D, the Engineering Department, was somewhat isolated and protected from frontline operations, which allowed for the possibility of long-term R&D projects like mortars. This long-term thinking was most cogently expressed in reports of the PIRA encouraging promising future technicians to remain in school in order to increase their technical knowledge, as in the case of Danny McNamee, who became a leading bomb-maker and was supported in his technical studies at Queen's University, Belfast, by the PIRA.[103] At the same time, the organization also made room for local EOs (explosives officers) in the various towns in the North to react to local conditions and independently engage in local-level innovation, which could then filter back to the centre.[104]

Safe Havens

The existence of a large area in the Republic of Ireland in which to conduct research, production and testing that was beyond the reach of British authorities has been identified as a key element in the success of the PIRA's mortar program.[105] At least in the early days of the development of mortars (during the first two phases of

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[101] McGuire, *passim*. Another example is Terry McIvor, who became a leading explosives and electronics technician for the Provisionals, while continuing his lecturer position in electronics at a college in Dundalk. See Bradley and Feeney, p. 131.

[102] Examples of technology purchased for the PIRA by its operatives include PULNIX light sensor systems to use as trigger mechanisms and 2,900 Ireco detonators from a company in Tucson in 1989. Author interview with former Northern Ireland law enforcement official 'D' and Oppenheimer (2009), p. 160.

[103] Oppenheimer (2009), pp. 275-276.

[104] For instance, Shane Paul O'Doherty – at the time the local Derry EO – who had a reputation for inventiveness was asked to come down South to consult with engineers who were developing the early mortars. Author interview with Shane Paul O'Doherty.

[105] Author interview with former Northern Ireland law enforcement official 'A'.

development), the Garda Special Branch was reportedly less than efficient or properly resourced in its operations. This allowed the PIRA (especially in areas of the Republic where it had strong local support) to engage in its development activities relatively unhindered, whereas in the North there was considerable pressure from the security forces, making any sustained R&D extremely difficult. One of the more infamous examples is the PIRA weapons factory discovered on a farm near Clonaslee, County Laois in June 1996, where – in addition to copious amounts of weapons and explosives – two senior PIRA technical officers were arrested while in the process of assembling mortars in a 14 x 8 foot bunker, which might have served as a testing range.[106] While some development did occur in certain Republican strongholds in Northern Ireland like South Armagh,[107] this is unlikely to have been sufficient to permit successive mortar developments over an extended period. It was pointed out to the author that it is no coincidence that the vast majority of mortar attacks took place in the southern part of Northern Ireland, close to the border with the Republic and to rural Catholic-majority Northern areas near the border.[108]

Culture of Learning

While Brian Jackson, in his seminal study of PIRA learning, identifies areas where its attempts to learn were of mixed quality,[109] in the area of weapons development the PIRA displayed an aptitude for learning that is unrivalled among terrorist groups.[110] The first form of learning it engaged in was pre-employment testing of weapons systems. The opportunity to remain relatively unmolested for much of the development period in the South and at times in the southern part of Northern Ireland presented ample opportunities for testing weapons. O'Callaghan describes firing mortars with dummy shells at Inch Strand on the inner side of the Dingle Peninsula, where the shells would land undamaged on the sandy beach,[111] while O'Doherty describes visiting a farm in

[106] Geraghty, p. 201.
[107] Indeed, several innovations such as radio-controlled devices and the large 'city destroyer' fertilizer bombs were allegedly produced in this area, as well as several mortar systems (Oppenheimer (2009), p. 114). Harnden, (p.233), describes the operatives in this area as having substantial mortar-related expertise, which they 'exported' to other areas of Northern Ireland.
[108] Author interview with former Northern Ireland law enforcement official 'B'.
[109] Jackson et. al., 'Provisional Irish Republican Army', p. 93.
[110] Ibid., pp. 115, 104.
[111] O'Callaghan, p. 86.

Kildare in 1972 where mortars were tested for range and weight-bearing capability.[112] However, this testing was far from foolproof, owing to the fact that the open spaces of rural testing areas differed from the mostly urban environment in which the mortars would be used.[113]

The second aspect of the culture of learning was the willingness and institutionalization of post-operation analysis. When things went wrong with an attack, the operatives conducting the attack would be debriefed by superiors. Of course, 'own goals' (where the PIRA operatives were themselves killed) made it very difficult to identify the source of the failure.[114] After-action reporting did not only occur when missions went awry – this practice was so pervasive[115] that it has been described as 'debrief – win, lose or draw'.[116] While the PIRA was unable to perform technical analyses of successful attacks or even observable failures (since the mortars or their remnants would be within the control of the authorities), they did the next best thing, by sending observers to stand at police cordons and try to gather as much information about the effects of the attack or the unexploded ordinance as possible.[117] This commitment to constant learning and improvement was a powerful enabler of the rapid development and success of the mortar program.

Negative Case Study: INLA

The Irish National Liberation Army (INLA) was a militant organization seeking to combine socialist revolution in the mould of James Connolly with the Republican ideal of reuniting Ireland. It was established on 8 December 1974 as a breakaway group from the Official Irish Republican Army (OIRA), from which the Provisional IRA had split five years previously and which had given up armed conflict in 1972. Led by the

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[112] O'Doherty recalls that on one occasion, the mortar shell 'went so far and buried itself underground that they couldn't find it' – author interview with Shane Paul O'Doherty.
[113] The author wishes to thank Interviewee B for this insight.
[114] 'Bombers', *Stirling Film Television Productions* (2012). Accessed at http://www.stirlingtelevision.co.uk/factual/bombers.html.
[115] It was not, however, universal, at least not in the early years of the Troubles. When asked, Shane Paul O'Doherty replied that there was not always debriefing (although much retrospective justification for outcomes) and what debriefing did occur was only at the level of the local commander, not the central leadership (author interview with Shane Paul O'Doherty).
[116] Author interview with former Northern Ireland law enforcement official 'D'.
[117] Author interview with former Northern Ireland law enforcement officials 'B' and 'C'.

charismatic Seamus Costello, the splinter group established a new political party, the Irish Republican Socialist Party, a subset of which formed a secret military organization, which eventually became known as the INLA.[118] The INLA engaged in bombings and shootings against its British and sectarian enemies from its inception, at times even outpacing the PIRA in the number and ruthlessness of its attacks. Among its most prominent attacks were the assassination of British MP Airey Neave at the House of Commons in London in March 1979,[119] a September 1982 destruction of a radar station in County Cork, Ireland,[120] the December 1982 bombing of the Droppin' Well Inn in Ballykelly,[121] the 'Darkley Massacre' in November 1983[122] and the killing of the leader of the Loyalist Volunteer Force, Billy Wright, in prison in December 1997.[123] INLA members also participated in the 1981 prison hunger strike.

However, the organization became embroiled in several bloody and debilitating feuds, first with the OIRA in 1975 that ultimately led to the killing of Costello in 1977, and then internal hostilities between several rival factions in the late 1980s and early 1990s. Another prominent example of internal destabilization is that of Harry Kirkpatrick, a senior INLA officer, who became one of the most prominent 'supergrasses'.[124] Fractious and partially descending into drug-related criminality,[125] the INLA eventually declared a ceasefire on 28 August 1998 (while rejecting the Good Friday Agreement), after which it finally achieved some degree of internal cohesiveness[126] before formally giving up its arms in February 2010.[127]

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[118] Jack Holland and Henry McDonald, *I.N.L.A: Deadly Divisions* (Dublin: Poolbeg Books, Ltd, 2010), pp. 1-50; Dillon, pp. 256-258.
[119] Ibid, pp. 262-263; Holland and McDonald, pp. 167-169.
[120] No author listed, 'In the Irish Republic, Five Hooded Gunmen Bombed a Government Radar Station', *The Telegraph,* 21 September 1982.
[121] Coogan, p. 535.
[122] S. Bloomer, *The History and Politics of the I.R.S.P. & I.N.L.A. from 1974 to the Present Day*, Unpublished dissertation, Document No. P15575, Northern Ireland Political Collection, Linen Hall Library, Belfast, p. 5.
[123] *BBC News*, 'Who are the INLA?' 14 September 2010. Accessed at: http://www.bbc.co.uk/news/uk-northern-ireland-11090412 on 10 October 2013.
[124] This is the term given to cases of captured terrorists who (usually in return for immunity from prosecution or a reduced sentence) gave information and testimony used to convict large numbers of their former comrades.
[125] Jim Cusack, 'INLA Man Feigned Friendship but Ordered my Death', *Independent* (12 August 2007). Accessed at:
http://www.independent.ie/opinion/analysis/inla-man-feigned-friendship-but-ordered-my-death-1056983.html on 10 October 2013.
[126] Henry McDonald, 'Terrorists Reach the Crossroads', *The Observer*, 16 October 1999. Accessed at: http://www.guardian.co.uk/uk/1999/oct/17/northernireland.theobserver on 10 October 2013.
[127] No author listed, 'INLA Decommissions Weapons After 35-year Irish Terror Campaign that Cost 100 Lives Including MP Airey Neave', *Daily Mail Reporter* (8 February 2010). Accessed at:

Although operating during much the same time period as the PIRA and directing its violence against a similar set of enemies, the INLA never developed or used any mortar system, or indeed any complex stand-off weapon at all. Investigating the reasons for this lack of weapons adoption despite almost identical environmental conditions to the PIRA can thus help illuminate the factors behind weapons adoption decisions.

The Innovations

While the INLA did not come anywhere close to the breadth or institutionalized nature of the PIRA's weapons adoption programs, this does not mean that the organization did not show inventiveness or did not innovate at all during its two and a half decades of armed opposition to the British government. In contrast to many descriptions of the organization, they have been described by the person who has studied them more closely than any other, investigative journalist Henry McDonald, as 'pathfinders',[128] technically, organizationally and in some of their political positions.[129]

The most prominent example of their technical prowess is in the organization's introduction of the mercury tilt switch, which was used to kill Airey Neave. Although the organization did not invent the device itself[130] it was the first to employ its potential as a motion-sensitive trigger for an explosive.[131] After several less publicized uses of the switch in a weapon,[132] on 30 March 1979, a team of INLA bombers magnetically affixed a bomb to Airey Neave's car at his apartment,[133] which armed itself after a timer had run out. Later that day, when Neave left the Houses of Commons and drove up a ramp, the switch detonated the bomb – killing a renowned World War II veteran and close friend of soon-to-be Prime Minister Margaret Thatcher. This attack, at the very heart of the British government, put the INLA on the map as a terrorist organization to

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http://www.dailymail.co.uk/news/article-1249365/Irish-National-Liberation-Army-Terror-group-murdered-Airey-Neave-decommissions-weapons.html on 11 October 2013.

[128] Author Interview with Henry McDonald, 19 June 2012.

[129] Ibid.

[130] Sheldon Bitko, *Mercury Tilt Switch,* U.S. Patent 3,978,301, filed 21 July 1975, and issued 31 August 1976. Available at: http://patft.uspto.gov/.

[131] Author interview with Andy Oppenheimer, 22 June 2012.

[132] Holland and McDonald, p. 167; Bloomer, p. 262.

[133] Paul Routledge, 'The Day I Met Airey Neave's Killers', *Mail On Sunday,* Morning Section (3 March 2002), p. 47.

be reckoned with. The mercury tilt switch would later become widely used by violent non-state actors in Northern Ireland.

In addition to innovating technically, the INLA innovated tactically, at least in terms of the audacity of their target selection. For instance, in 1978, the organization attempted to kill the British Ambassador and military attaché to Ireland by hiding a remote control bomb in a prayer stool in St. Patrick's Cathedral in Dublin.[134] The bomb would have damaged the church and could have killed many supplicants. Fortunately, the detonation signal could not penetrate the thick stone walls of the cathedral and the attack failed.

Yet despite these early signs of innovation, there is no evidence whatsoever of the INLA even attempting to use mortars, whether self-produced or otherwise. The available literature does not mention any such attempts and a search for the INLA in the Global Terrorism Database, the most comprehensive open-source database of terrorist incidents since 1970,[135] revealed only two attacks involving anything resembling a mortar. Upon closer investigation, both these attacks, one of which involved a rocket-propelled grenade and the other a mortar, turned out to have been perpetrated by the Provisionals rather than the INLA.[136] We can thus confidently assume that this was an innovation the adoption of which was not even attempted by the INLA.

In the absence of a mortar development process to act as a guide to dividing the period of INLA operations, the span of INLA activity was broken up according to observed major organizational changes:[137]

1. *The Formative Years through the McGlinchey Era* (1974 to 1985): This phase covers the formation and early years of the organization under Seamus Costello, and after his death the brutal, authoritarian, but nonetheless still relatively cohesive, period under the direction of Dominic 'Mad Dog' McGlinchey.
2. *Riven and Declining* (1986 to1998): The second phase begins with the late-1980s feuds and internal bloodletting, followed by the steady decline of the

[134] Holland and McDonald, pp. 161-162.
[135] Global Terrorism Database.
[136] Malcolm Sutton, *CAIN Database of Deaths*, 20 September 1982. Accessed at http://cain.ulst.ac.uk/sutton/chron/1982.html on 6 October 2013; No author listed, 'Northern Ireland; IRA Guerrillas Attack Army Post', *St. Louis Post-Dispatch* (25 February 1991), p. A8.
[137] It is possible to divide up each of these periods further, although there is no prima facie indication that this would provide greater analytical value.

organization and its partial descent into petty criminality, until its 1998 ceasefire declaration.[138]

Innovation Awareness

Before asking why the INLA did not adopt mortars, it is necessary to establish that they were even aware of mortars as a potential innovation. The preponderance of evidence points towards an awareness of mortars. First, many of the founders of the INLA came from much the same Republican origins as those in the PIRA, through membership in the old IRA. Seamus Costello, for instance, was referred to as the 'Boy General' for his exploits on behalf of the IRA in the border campaign of the 1950s and early 1960s. They would therefore have had similar opportunities as the Provisionals to come into contact with experiential knowledge of military matters (in particular, mortars) held by IRA veterans of World War II and previous campaigns. Indeed, the INLA was known to have included some ex-Army personnel within its ranks.[139] Sharing the same enemies as the PIRA, the same tactical and strategic exigencies that perhaps prompted the Provisionals to first become interested in mortars (e.g., hardened walls around police stations and a desire to avoid harming civilians where possible), would have made mortars an equally logical military proposition for the INLA.

Most obviously, by the time that the INLA was formed, mortars had already been used in the Northern Ireland conflict. Not only had the PIRA already launched many attacks with mortars in the two years preceding the 1974 formation of the INLA and thus brought the potential of mortars to the public consciousness, but the direct forerunner of the INLA, the OIRA, had itself attempted to use mortars only a year previously. In 1973, the OIRA (despite its ceasefire) had planned a series of coordinated mortar attacks against British army bases in Northern Ireland and had trained some of its volunteers in the use of mortars at a camp in County Tipperary.[140] These mortars were improvised and have been described as being 'of reasonably good quality'.[141] The actual

[138] In the case of both the INLA and the PIRA, the organization continued to function and even engage in limited violence (mostly related to purely criminal activities) for several years after their formal ceasefires. However, 1998 signalled the last year that either group targeted its avowed enemies (the British government, Loyalist paramilitaries and the Northern Ireland security forces) for ideological purposes, hence marking the end of their 'terrorist campaigns'.
[139] Author Interview with Henry McDonald.
[140] Holland and McDonald*,* p. 25.
[141] Ibid.

attacks were a failure, with only a single mortar firing but causing no injuries.[142] However, it can hardly be credibly argued that those in leadership positions in the INLA, who would at the very least have known about – if not been a part of – this planned operation, would have been oblivious to the existence of a mortar option.

The Adoption Decision

A more vexing question is why, if they were aware of the potential of mortars, did the leadership of the INLA not pursue this option? As in any investigation into a non-event related to clandestine actors, there is a great deal of uncertainty associated with any conclusions that are drawn. In the current case, however, there is a strong argument to be made that the following inter-related factors played a significant role in the failure of the group to pursue a mortar capability:

1. *Feuds and Internal Tensions*: Most terrorist groups, perhaps as a consequence of the high levels of zeal, stress and a proclivity towards violent action, experience some degree of internal dissension and rivalries, at times resulting in splits, splinters and other forms of organizational fission. Yet, the INLA stands out in this regard as an organization so beset by factionalization and (almost existential) internal enmities during the course of its history, that the strategic – and hence tactical – development of the organization, at least with respect to its campaign of violence, was severely stunted. Occurring right at the inception of the organization, the early 1975 hostilities with the OIRA that followed the IRSP/INLA breakaway[143] was viewed – even at the time – as having a deleterious effect on the INLA's strategic development.[144] Perhaps more importantly, there were at least two fundamental axes of tension within the organization that arguably hobbled it for much of its existence. The first was a tension between the leadership of the INLA based in Dublin and those members based in Belfast, who at

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[142] Ibid. A British soldier was killed but only when he foolishly handled a malfunctioning mortar in its tube.
[143] See 'Paramilitary Feuds in Northern Ireland—A Chronology of Events' *CAIN Web Service*, accessed at: http://cain.ulst.ac.uk/issues/violence/feudchron.htm on 4 November 2013, for a list of the feud's violent acts.
[144] Costello had wanted to refrain from announcing the existence of the IRSP's military wing until the organization had had the opportunity to acquire sufficient weapons and conduct a number of attacks to give itself credibility. The 1975 feud with the OIRA forced the organization to reveal itself before he believed that it was ready (Holland and McDonald, pp. 63-76; Interview by Henry McDonald of Terry Robson held in the Northern Ireland Political Collection of the Linen Hall Library, Belfast, conducted April 2-3, 1993).

times operated outside of Dublin's command or control.[145] The second axis of tension formed between the militants in the INLA and the movement's political wing, the IRSP, with the latter moving away from traditional Republicanism and eventually adopting an extreme Marxist-Leninist position in the 1980s.[146] These 'fault-lines in the DNA'[147] of the INLA would ensure that it would never be a coherent organization.

Steadily rising tensions in the early 1980s, exacerbated by dirty laundry aired during a series of supergrass trials, eventually boiled over into a bloody four-way feud after the capture of the INLA's de facto leader, Dominic McGlinchey, in 1984.[148] While the dynamics were complex, the strife pitted a faction led by the new self-declared leader of the INLA, Belfast-based John O'Reilly, against a coalition made up of the former Dublin-based leadership on the Army Council, a group of mostly former prisoners gathered around Gerard Steenson, and a new offshoot known as the Irish People's Liberation Organization (IPLO).[149] This resulted in many prominent members losing their lives in the bloodletting that followed, including the Paris-based Seamus Ruddy, Thomas 'Ta' Power, and O'Reilly himself.[150] Thereafter, another member, Dessie O'Hare, formed his own faction in the border area and engaged in a series of vicious assaults.[151] The feuding resumed in the 1990s, with the killing of a new INLA boss, Gino Gallagher, in 1996, and finally came to an end later that year, after the murder of Hugh Torney, a long-time leading figure in the INLA.[152] The fractiousness of the INLA, which spasmodically erupted in internecine violence, left the organization disorganized and debilitated for much of its history. This was hardly conducive to accomplishing any strategic goals, let alone the setting up and maintenance of an external, international acquisition channel for mortars, or the internal development of a mortar capability.

2. *Leadership Deficiencies and Turnover*: The INLA was formally organized along similar lines to the PIRA, with an Army Council and General Headquarters Staff

[145] An early example was the shooting of a respected OIRA leader, Billy McMillen, by a young Gerard Steenson, who was later to receive the moniker 'Dr. Death' and play a major role in the INLA's misfortunes (Holland and McDonald*,* p. 60).
[146] Ibid., p. 368.
[147] Author Interview with Henry McDonald.
[148] Holland and McDonald, p. 254; author Interview with Henry McDonald.
[149] Holland and McDonald, pp. 315, 340; Craig and Geldard, IRA, p. 16.
[150] Ruddy was allegedly tortured and killed by O'Reilly, who was looking to acquire weapons, in 1985 (Coogan, pp. 541-542), while Steenson headed up the assassination of Powers and O'Reilly at the Drogheda hotel in January 1987 (No author listed, 'The INLA Devours Itself', *Magill,* 10:7, p. 17).
[151] Holland and McDonald, p. 369.
[152] 'Paramilitary Feuds in Northern Ireland'.

presided over by a Chief of Staff and different brigades at the operational level.[153] Yet, partly as a cause and partly as a consequence of the internal feuding, the leadership of the organization – with the exception of the group's founder, Seamus Costello, until 1977 – was neither stable nor forward-thinking. By some counts, the INLA had no less than a dozen different Chiefs of Staff during its almost quarter century of armed struggle,[154] not to mention periods when the Army Council was essentially ignored or moribund. For example, with the rise of Dominic McGlinchey in 1981, he (sometimes brutally) imposed 'Direct Military Rule' and operated without obtaining authorization from the Army Council or GHQ staff.[155] There does not seem to have been much opportunity for any leader to settle into his position and direct the organization in any long-term endeavours, least of all those involving fairly unfamiliar weapons systems that required training, practice, and iterative refinement.

Moreover, many of the leaders appeared to be hot-headed and more interested in securing and preserving their power base than in developing and implementing coherent strategies and organizational growth. The lack of steady leadership to lend sustained support to an acquisition or development effort and the almost constant internal jockeying for position meant that even if there were innovative and forward-thinking technicians within the INLA's ranks, they most probably would have viewed adopting a new weapons system like mortars as a decidedly risky proposition – both in terms of technical prospects for success and for their standing in the organization. The situation is best summed up by one of the prison 'comms'[156] issued by Gerard Steenson (himself having played no small role in the instability of the organization) in the mid-1980s: 'The word L/ship is a misnomer as none effectively exists or functions. There is no national movement under their control'.[157]

The innovation-dampening effects of leadership uncertainty and insecurity are perhaps best illustrated by exception; arguably the organization's greatest technical innovation, the adoption of the mercury tilt switch that was used, among others, in the bomb that killed Airey Neave in 1979, took place during a period of relative stability in leadership.

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[153] Interestingly, the brigades actually had units based on a cell system years before the PIRA adopted this model (Dillon, p. 257).
[154] Robson interview; Holland and McDonald, *passim*.
[155] 'The INLA Devours Itself', p. 24.
[156] Messages smuggled from members in prison to those on the outside, usually written on tiny, easily concealable pieces of paper.
[157] Holland and McDonald, p. 322.

Although the Chief of Staff position was in flux during this period, senior operational control was maintained from 1976 to 1980 by the Belfast Officer Commanding, Ronnie Bunting, by all accounts a capable and deliberate man.[158] It was apparently under his guidance and direction that the decision to target Neave with a weapon using the new trigger mechanism was made.[159]

3. *No Institutionalized R&D or Weapons Acquisition Capability*: At no time did the INLA establish a formal analogue to the PIRA's Engineering Department, i.e., an institutionalized R&D organ whose function it was to undertake complex weapons development over an extended period of time. Nor was it ever able – despite connections with several other terrorist groups, including Action Directe in France,[160] the Cellules Communiste Combattant (CCC) in Belgium,[161] the Red Army Faction in Germany[162] and the Palestine Liberation Organization's Fatah wing[163] – to cultivate the infrastructure required to import large numbers of weapons, especially anything more complex than small arms. Unlike the PIRA, the INLA had almost no state support and on the one occasion when Libya allegedly offered the organization weapons, the INLA was forced to reject the offer on the grounds that it was unable to deal with bringing them into Ireland or absorbing shipments of the size that Libya envisaged sending them.[164]

4. *Resource Shortages*: In spite of the numerous international connections that the INLA did manage to make, primarily with other left-wing militant organizations in Europe, these did not translate into copious amounts of resources. While they did provide a source of small arms (pistols, hand grenades and so forth) and explosives, the INLA's external connections did not provide much in the way of hard currency for the

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158 Holland and McDonald, pp. 146-148.
159 Author interview with Henry McDonald.
160 Holland and McDonald, pp. 298-299.
161 In June 1984, the INLA reportedly received a share of the spoils from a joint operation with Action Directe and the CCC in which 816 kilograms of plastic explosives were stolen from a quarry in Belgium (see Craig and Geldard, p. 37).
162 The INLA had some members based in Paris and received several shipments of weapons from there (Craig and Geldard, p. 23).
163 Craig and Geldard (pp. 68-69) suggest that the idea for using the mercury tilt switch might have actually originated with the PLO, after two Palestinian bomb experts visited Ireland in 1978. For more on the relationship with the PLO, including training at a PLO camp in Lebanon and the provision of arms to the INLA, see Holland and McDonald, p.157; No author listed, 'INLA's New Threat to NATO', *Sunday World*, 3 February 1985; 'The INLA Devours Itself', p. 20; and Dillon, p. 263.
164 Holland and McDonald, pp. 303-304.

INLA. Indeed, the organization was perennially short of money[165] – it lacked the Irish-American funding stream or legitimate front businesses enjoyed by the PIRA and its following was too small to contribute much to the military coffers through the sale of magazines like the Starry Plough, the IRSP's chief periodical. The INLA therefore had to rely primarily on criminal activities to fund its armed struggle, including armed robberies and later on extortion, kidnapping and an increasing involvement in illegal narcotics markets in Ireland.[166] There were some spectacular successes in the group's criminal exploits, the most notorious being the 1978 robbery of roughly £460,000 from an armoured Brinks-Mat truck near the Barna Gap,[167] after which members were said to have 'slept in flats on layers of banknotes'.[168] However, such infusions of cash were sporadic and ephemeral, and overall the organization was often suffering from severe shortages of funds.[169] The lack of stable funding sources introduced a high level of uncertainty into their operational planning; these were not quite the ideal conditions under which an organization could begin a weapons procurement or development program that could be expected to have unforeseen, but likely fairly substantial, costs. In addition to being short of funds, the INLA, primarily due to its smaller size and limited appeal in the Catholic community of both the North and the South, also did not possess the same logistical backbone as the PIRA in terms of supporters willing to provide safe houses or farms in remote locations for training or testing purposes. The INLA did have some logistical support and training areas[170] and people like Dominic McGlinchey were able to survive on the run for months on end, but there are no similar accounts of the Gardai uncovering large INLA weapons factories or repositories in the Republic of Ireland, as there were with the Provisionals.

[165] Ibid, p. 177.
[166] At times, these activities almost brought the INLA into open conflict with the PIRA, for example, in 1984 when INLA members began to extort money from Catholic businessmen already dealing with the PIRA (S. Freeman and B. Penrose, 'INLA muscles in on rackets', *Sunday Times* (17 June 1984), p. 1).
[167] The money was primarily intended to purchase weapons (Holland and McDonald, pp. 156-157).
[168] Robson interview, p. 1.
[169] While it is it is unclear as to exactly how much money the INLA possessed at any point in time, one can get some idea of the overall movement's financial situation by consulting the IRSP's meeting minutes. In 1976, the party had an income of less than £6,000 with debts of over £17,000 (Holland and McDonald, p. 129), while by 1977, the situation was worse, with the IRSP possessing a grand total of £393.91 in disposable income (Holland and McDonald, p. 146). While it might be argued that the lack of funds in the political wing signalled that all available funding was being channelled to the military wing, this is made less plausible by the sheer paltriness of IRSP funds – surely, even if relations between the political and military wings were strained, were the INLA to have possessed significant resources, at least a token amount would have been given to the IRSP to cover its debts.
[170] Terry Robson described INLA training camps in the Mamore Gap, Inishowen, Fintown, central Fonegal and the Wicklow Mountains (Robson interview, p. 1).

5. *Limited Talent Pool for Weapons Adoption*: While the Provisionals were awash with innovative individuals who were willing to dedicate themselves to improving its arsenal, this does not appear to have been the case with the INLA. First, its smaller size[171] meant that there were simply fewer people overall who engaged at any level in the armed struggle and consequently fewer members available to focus on weapons procurement and development, especially if the organization wanted to keep up a high tempo of actual attacks, which required volunteers to be on the 'front lines'.

Second, there was the quality of the personnel it did have. It was not that the INLA was completely devoid of talented individuals or that its membership was necessarily opposed to innovation.[172] The organization counted within its ranks some ex-Army members and personnel who were trained by other militants in the Bekaa Valley in Lebanon, as well as at least some innovative individuals, such as the unidentified member who developed and then demonstrated the mercury tilt-switch's effectiveness to the leadership in 1978.[173] After all, the INLA had inherited many members from the OIRA, whose cadre had reportedly been well trained.[174] It obviously possessed sufficient expertise in explosives to produce dozens of successful bombs during its active lifespan.

However, overall the INLA's expertise was not on par with the Provisionals when it came to variety or ingenuity. One reason may have been that the expertise that the INLA did inherit was somewhat diluted – when the Provisionals had split from the OIRA in 1969, they had taken many of the best technical people with them, weakening the OIRA in this regard. When the INLA formed from the 'Stickies' in 1974, it could only draw on this more limited pool of technical talent, and only a portion of these people ended up joining the INLA.[175] Later recruits with prior training who joined the

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[171] Although it initially claimed to have several hundred members in 1975, shortly after its creation (Holland and McDonald, pp. 51, 131), this number declined precipitously thereafter (if indeed it had ever been so high), with only an estimated maximum of forty active members in Northern Ireland by 1985 (No author listed, 'The McGlinchey File', *New Hibernia* (3 October 1985), p. 3).
[172] With respect to INLA attitudes towards new technology, Terry Robson, a former senior member of the IRSP, has stated that 'they didn't want to be seen running around with shotguns. They wanted to demonstrate that they were a real organization by running around with high-tech stuff' (Robson interview, p. 4).
[173] The organization was also reportedly able to draw on the services of three middle-class professionals to carry out the Airey Neave attack; these men were allegedly used for this one, high-profile assassination alone and were then allowed to retreat into obscurity (Routledge, p. 17; Dillon, pp. 285-286).
[174] Jim Cusack, 'IRA –INLA Clash over Fund Raising Issues', *Irish Times* (26 July 1984), page unknown.
[175] Author interview with former Northern Ireland law enforcement official 'D'.

INLA were described by Brendan O'Brien as 'mainly [coming] from IRA dropouts'.[176] Furthermore, many of the people they did recruit were quite young, and the organization was accused at certain times of being less than particular about who it admitted into its ranks.[177] Perhaps this is why several of those interviewed in connection with this project described the INLA's cadre using terms such as 'basically street thugs' possessing 'no military discipline',[178] who were 'game for anything'[179] and engaged in 'no real conscious reflection'. [180] None of these are traits associated with the dedicated and systematic experimentation and learning that is arguably necessary for successful innovation. Indeed, one former law enforcement official the author consulted was of the opinion that much of the INLA's tactical ethos was centred on acting rather than deliberating, that the goal of attacks was often more than not about personal glorification and the desire to be seen as a 'hero' amongst one's peers and that as a consequence INLA members basically used what they had to hand rather than worrying about acquiring something new.[181]

The above factors taken together paint the picture of a fractious organization with high leadership turnover, individual jockeying for status and position, resource shortages and a cadre mostly dominated by young 'hotheads'. This is an organizational environment in which there is little scope for anything more than a tooth-and-nail struggle against enemies both internal and external, with almost no organizational space to consider any innovation, like mortars, that would require a stable strategy and long-term investment of resources. It is most probable then, that amidst the maelstrom that was the INLA's daily experience, there was no serious consideration of adopting mortars. This would be not so much a decision not to adopt as an organizational inability even to make such a decision. One can imagine those leaders who were even aware of the potential utility of mortars in all likelihood putting off thinking any further about the issue until 'things settled down' – which, of course, they never really did.

In the rather unlikely event that any enlightened INLA members, be they among the leadership or the rank-and-file, did give a degree of sober consideration to whether or

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[176] O'Brien, p. 40.
[177] Cusack, 'IRA—INLA Clash over Fund Raising Issues'.
[178] Author interview with Andy Oppenheimer. Similar sentiments were expressed by former law enforcement official 'C'.
[179] Author interview with former Northern Ireland law enforcement official 'C'.
[180] Author interview with Henry McDonald.
[181] Author interview with former Northern Ireland law enforcement official 'D'.

not to adopt a new and innovative weapon like mortars, they would undoubtedly have been aware of the organizational weaknesses listed above and invariably have come to the perfectly rational decision that the organization was simply incapable of carrying out such an adoption in its present state. In other words, they would have realized that the members of the organization simply 'weren't up to it'[182] and would have dismissed the possibility of adoption.

[182] Author interview with Andy Oppenheimer.

Table 6.1: PIRA Mortar Development

Relevant Period		Designation	Date First Aware	Range	Payload	Other Salient Characters	Notable Associated Attacks	Notes
Prior to 1972	*No Capability*	'Spigot Grenade'[a]	Early 1970s		2 kg gelignite	- 15 cm pipe. - Fired from shotgun.		- Developed to deal with fortified police stations. - Viewed as too dangerous for volunteers to use.
1972-1974	*Intense Experimentation*	Flare 'Mortar'[b]	1973	'flew far'	'limited' amount of PETN	- 'Proto-mortar' using marine flares. - Replaced flare material with detonator, explosive and a fuse.		- Did not catch on beyond Derry.
		Mark 1[c]	June 1972		250g commercial plastic explosive	- Mortar made up of 50mm copper pipe; .303 cartridge in rear as propellant. - Triggered by driving spike against .22 cartridge (probably nail gun-type 'Hilti' cartridge) to ignite detonator. - Described as having an ingenious nose-cone fuse design.		- Would spin once took off. - No safety mechanism so dangerous to user. - Failed to explode if fuse damaged by impact at wrong angle.
		Mark 2[d]	December 1972		1 kg commercial explosive	- 20cm long, 57mm diameter steel pipe. - 12-gauge shotgun cartridge as propellant. - 5 second delay from impact to ignition from split fuse - Modified, more reliable nose cone.	- First PIRA mortar fatality: British soldier attempting to defuse wayward mortar fired in Turf Lodge, Belfast in December 1972.	- Often fired through the roof of the target building. - Used 25 times in its first four months. - Accuracy still poor because of base-plate movement.
		Mark 3[e]	1973	250m; 'buried itself underground when fired into sand' (O'Doherty)	0.5 kg high-grade crystalline ammonium nitrate, boosted by aluminium powder	- 60mm mortar barrel; static firing pin and Hilti cartridge as detonator; 'J-cloth' (sodium chlorate-soaked) used as a propellant. - Accuracy increased through use of stronger base plate and configurable aiming quadrant. - Cut main explosive charge by half from previous model.	- Attacks on Creggan Camp, Derry and Lisanelly barracks, Omagh in 1973 (16 mortars). - Failed attack on RUC Pomeroy barracks in August 1973 resulted in two IRA men killed.	- Highly volatile explosive tended to explode prematurely. - Unreliable, given to tumbling in flight. - Accuracy within 30m over 300m. - Used 105 times in 14 separate attacks in first six months.
		Mark 4[f]	1974	400m	0.45 kg ammonium nitrate, with up to 15% aluminium powder	- Extended range version of Mark 3. - Used greater amount of J-cloth as the propellant. - Contained ball bearings	- Attack on base at Strabane (14 mortars did not function).	- Dangerous - could explode in tube and no safety mechanism. - Abandoned in six months.

[a] Oppenheimer, p. 229.
[b] O'Doherty interview.
[c] O'Doherty interview; Geraghty, p. 88; Oppenheimer, p. 229.
[d] Malcolm Sutton, *CAIN Database of Deaths*, 10 December 1972. Accessed on 6 October 2013 at: http://cain.ulst.ac.uk/sutton/chron/1972.html; Horgan and Gill, p.11; Oppenheimer, p. 229.
[e] Geraghty, p. 189; Horgan and Gill, p.11; Chris Ryder, *A Special Kind of Courage: 321 Squadron – Battling the Bombers* (London: Methuen, 2006), p.215; O'Doherty interview; Oppenheimer, pp. 229-230.
[f] Horgan and Gill, pp.11-12; Geraghty, p. 189; Oppenheimer, p. 231.

						- No safety mechanism, so used as traditional military mortar.		
		Mark 5[g]	1974	25m		- 'Bombard'-like.	- Never used.	- Discovered during raid on IRA workshop in Antrim in 1974.
		Mark 6[h]	1974	1,097m	1.36 kg explosive charge (often Semtex), detonated by .22 cartridge on impact	- 60mm calibre. - Standard launch tube, strong base plate and bipod. - .22 calibre cartridge initiated homemade gunpowder propellant after dropping mortar shell down tube. - Contained an impeller to arm itself during flight (advanced technology). - 8 aluminium fins. - Electric trigger system using remote control technology.	- Cross-border attack on County Armaugh army observation post in 1974. - Extensive damage caused when thrown by hand onto roof of armoured vehicle, Divis Flats, Belfast in 1987. - 1994 Heathrow attacks.	- First reliable device (much safer and longer range minimized risk of detection). - Warheads in Heathrow attacks made from drainpipes with tailfins. - 28 intact units found in Belfast bakery in 1974; allowed security forces to gain intimate knowledge of working.
1975-1987	*Approaching Military Grade*	Mark 7[i]	1976		> Mark 6	- Longer version of Mark 6 (1m tube).	- Used against Army-RUC base at Crossmaglen in 1976.	- Poor flight stability because of length. - Sacrificed accuracy for greater payload.
		Mark 8[j]	1976		> Mark 6	- Longer version of Mark 6 (1m tube). - 'Cannibalized' version of earlier models.		- Poor flight stability. - Less sophisticated.
		Mark 9[k]	1976		5 kg explosive	- Produced from cut-down gas cylinders, so shorter, fatter profile. - Could be launched in groups of up to 10 tubes.	- October 1976 attack on Crossmaglen base; 7 mortars detonated. - 1977: 5 warheads off target landed in school grounds in Belfast.	- Sacrificed accuracy for explosive payload.

[g] Geraghty, p. 190; Oppenheimer (2009), p. 231.
[h] Geraghty, p. 191; Oppenheimer (2012); Oppenheimer (2009), pp. 170, 231-232.
[i] Oppenheimer (2009), p. 233
[j] Ibid., p. 233.
[k] Ibid., p. 234.

		Mark 10[l]	1979	300m	Variously reported as 11kg (Boyne and Horgan) and 20kg-100kg (Geraghty and Oppenheimer) explosive (1991 attack used "ANNIE" ammonium nitrate and nitrobenzene mix; sometimes Semtex)	- 150 mm diameter, 1.2m warhead made from gas cylinders). - Fine black powder as propellant in base allowed accurate ranging. - Incorporated safety pin and weight-based safety mechanism with detonation on impact. - Detonated by electrical timers. - Multiple (up to 10) launch tubes ('set at varying angles for maximum target coverage' - Oppenheimer, p. 234).	- First fatality caused by mortar attack in South Armagh in March 1979. - Corry Square Police Station, Newry attack - April 1980. - 1985 Newry police station attack (9 killed). - Used in 1991 attack on British Cabinet on Downing Street.	- Often launched from back of truck. - Incorporated incendiary in base/launchers to destroy forensic evidence after launch. - Became 'workhorse' of mortar arsenal during 1980s, but 'wide angles' of attack meant that chances of civilian injury still high.
1988-1998	*Bigger and Better*	Mark 11[m]	1989	519m	10 kg (often ANNIE)		- Used May 1989 against British Army observation post, Glassdrumman, South Armagh.	
		(Mark 12[n])	1989		2.5 kg Semtex	- Not actually a mortar, since utilized direct fire from a horizontal position. - 75cm long. - Inertia fuse and triggered by command wire or timer. - Employed a shaped charge to pierce armour.	- Attack on Crossmaglen, October 1989.	- Ostensibly made British armoured vehicles obsolete.
		Mark 13[o]	1990	35m	36 kg	- Made from 45-gallon oil drum. - Launched from a spigot. - Short range meant required truck or tractor as a launching pad.	- First used in attack on Dungannon, May 1990.	- Sometimes used diesel fuel tanks as projectiles.
		Mark 14[p]	1992		20 kg of home-made explosive	- Made from top halves of two gas cylinders welded together.	- May 1992 attack on Crossmaglen base.	
		Mark 15[q]	1992	100-275m (depending on version)	70-75 kg of ammonium nitrate	- 360mm diameter cylinder. - Tube was 3 metres long. - Included coins as shrapnel.	- Army base in Ballygawley, County Tyrone, December 1992. - British base in Osnabruck, Germany in June 1996.	- 'Barrack buster'. - Brought down British helicopters in March, July 1994. - Improvised from widely available gas cylinder used for cooking / heating.

[l] Ibid., pp.193, 234-235, 320-321; Horgan and Gill, pp.11-14; Geraghty, pp.192-195; Sean Boyne, 'Uncovering the Irish Republican Army: Weapons', *Jane's Intelligence Review,* 1 August 1996. Accessed at http://www.pbs.org/wgbh/pages/frontline/shows/ira/inside/weapons.html on 6 October 2013, p. 3; Toolis, p.52.

[m] Geraghty, p.192; Horgan and Gill, pp.11-14; Oppenheimer (2009)*,* p.236.

[n] Author interview with Jim Cusack; Horgan and Gill, pp.11-14; Oppenheimer (2009), p. 236.

[o] Oppenheimer (2009)*,* p. 237.

[p] Ibid., p.237; Horgan and Gill, pp.11-14.

[q] Geraghty, p. 193; Oppenheimer (2009), pp. 187, 238; Harnden, p. 398.

		(Mark 16[r])	1993	Effective 20-25m, up to 200m	900g Semtex	- Horizontal, direct fire weapon (like Mark 12). - Small and lightweight, no anchoring of base plate required (could be shoulder launched). - Shaped charge.	- July 1993 attack on William Street, Derry.	- Sometimes launched from under bonnet of car. - Unlike Mark 12, made from easily acquired parts with minimal machining needed.
		Mark 17[s]	1994-1995			- Described as one of IRA's most destructive weapons.	- Never used.	- Built during mid-1990s ceasefire.

[r] Oppenheimer (2009), p. 238.
[s] Boyne, 'Uncovering the Irish Republican Army: Weapons'.

Chapter 7: The American Far Right and the Adoption of Cyanide and Rockets

The second set of case studies compares the weapons adoption behaviour of the Covenant, the Sword and the Arm of the Lord (CSA) and the Order, two violent groups active in the American far right ideological milieu in the early 1980s. For these cases, two dissimilar weapons types are considered, namely cyanide and rockets. Although neither organization ultimately succeeded in adopting these weapons, the CSA made concerted efforts to do so, while the Order was largely content with utilizing guns and simple explosives.

Positive Case Study: The Covenant, the Sword and the Arm of the Lord

The Covenant, the Sword and the Arm of the Lord (CSA) was a millenarian, survivalist Christian Identity[1] organization that engaged in a wide variety of paramilitary and violent activity in the United States in the early 1980s. Centred on James Ellison, their charismatic religious leader, the organization operated out of an isolated settlement located near the Arkansas-Missouri state border. The CSA had its origins as a Christian fundamentalist commune founded in 1971, when Ellison moved to the Ozarks region from San Antonio, Texas, before purchasing a 224-acre plot of land around Bull Shoals Lake in Marion County, Arkansas in 1976.[2] At first, the group did not embrace violence, emphasizing a pious communal lifestyle removed from the sin and corruption of the outside world. However, under Ellison's direction the group's ideology mutated into ever more virulent forms. It first took on apocalyptic millenarian tropes in 1978, which led to a perceived need to acquire weapons and training to protect the community during the imminent, prophesied time of Tribulation. Eventually the group adopted the tenets of Christian Identity wholesale by late 1979.[3] This transition was signified by the

[1] The tenets of the Christian Identity doctrine will be described fully below.
[2] No listed author, *Hate Groups in America: A Record of Bigotry and Violence* (New York, NY: Anti-Defamation League of B'nai B'rith, c. 1988), p. 52.
[3] Kerry Noble, *Tabernacle of Hate: Seduction into Right-Wing Extremism, 2nd ed.* (Syracuse, NY: Syracuse University Press, 2010), p. 103; Mark S. Hamm, *Terrorism as Crime: From Oklahoma City to Al-Qaeda and Beyond* (New York: New York University Press, 2007), p. 93.

group – originally called the 'Zarephath-Horeb Community' after two sites of biblical significance[4] – adopting the more militant public name of 'the Covenant, the Sword and the Arm of the Lord'[5] in 1981. The CSA, at one stage growing to around 150 members,[6] became increasingly enmeshed in radical right-wing circles, with Ellison exhibiting ever more grandiose aspirations, to the extent of having the Identity preacher Robert Miller crown him as 'King James of the Ozarks' in 1982.[7]

What followed was a remarkable array of criminal and violent activities, ranging from petty theft, welfare fraud and arson to attempts to destroy federal government buildings and gas pipelines, plots to assassinate judges, and even plans for engaging in mass poisonings of American cities. By 1985, federal law enforcement authorities were closing in on the group and the prospect of right-wing extremist fugitives seeking refuge at the CSA compound in April 1985 precipitated a four-day standoff between the heavily-armed inhabitants of the CSA and over two hundred law enforcement agents. At the conclusion of this standoff, Ellison and other residents with outstanding warrants for their arrest surrendered to authorities,[8] which heralded the denouement of the group, as several members served prison terms and the remainder dissolved. However, evidence

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[4] The Bible (1 Kings 17) describes Zarephath as the city to which Elijah the prophet fled when pursued by the evil King Ahab and performed the miracle of raising the dead there. After successfully challenging the idol-worshipping priests of Baal, Elijah fled to Horeb, which is the same location as Mt. Sinai, where the Children of Israel received the Ten Commandments from God. There Elijah found the oft-quoted still, small voice of God amidst wind, earthquakes and fire. The symbolism of the choice of name was apparently thus a place of divine revelation that served as a refuge from the unclean practices of the outside world (Noble, p.69). Other observers have referred to the name as denoting a purging place (Brent L. Smith, *Terrorism in America: Pipe Bombs and Pipe Dreams* (Albany: State University of New York Press, 1994), p. 63; *Hate Groups in America*, p. 52).

[5] The 'Covenant' in the title ostensibly refers to the bond between God and his chosen people. According to Stern, who cites Leviticus 26:35 and Deuteronomy 7:19, the 'Sword' refers to God's anger against those who do not obey his commandments and the 'Arm of the Lord' represents God's omnipotence (Jessica E. Stern, 'The Covenant, the Sword and the Arm of the Lord (1985)', in Jonathan B. Tucker (ed.), *Toxic Terror*, p.145). Jean Rosenfeld describes the name change as reflecting the group's redefined mission of physically defending the White race during God's apocalypse (Jean Rosenfeld, 'Introduction' in Noble, p. xxiv). James Coates notes that the initials are the same as those of the 'Confederate States of America', the name adopted by the South during the U.S. Civil War (James Coates, *Armed and Dangerous: The Rise of the Survivalist Right, 3rd ed.* (New York, NY: Hill and Wang, 1995), p. 136). Although he does not elaborate, if this is not a coincidence it might reflect a racist nostalgia for the days of slave-ownership and rebellion against the sitting federal government. For purposes of parsimony, this study will refer to the organization as the CSA throughout, unless a particular distinction is warranted between the two phases of the organization.

[6] Before a split in December 1982, following which several dozen members left the group, Kerry Noble estimates that there were up to one hundred and fifty members (Noble, pp.128, 144), although a declassified FBI intelligence report from 1982 estimates the number of members at no more than one hundred and twenty persons (Federal Bureau of Investigation, *Information on the Covenant, the Sword and the Arm of the Lord* (2 July 1982), File No. 100-HQ-48720).

[7] Hamm, p. 99.

[8] Noble, p. 219.

that emerged from subsequent searches of the CSA compound as well as testimony at the trials of various CSA members revealed an organization that possessed a well-developed armaments capability and had at least attempted several weapons innovations during its relatively brief campaign of violence. Two of these will be explored here: the CSA's attempts to acquire the capability to launch rockets to destroy a large building and the group's acquisition of and plans for utilizing cyanide as a weapon of mass destruction.[9]

The Innovations

It was not just in the areas of rockets and chemical weapons that the CSA sought to innovate – the organization displayed a much broader pattern of weapons adoption and adaptation. This general penchant for weapons innovation serves to bolster many of the arguments that will be made with respect to the weapons focused on here so, prior to detailing the particular adoption of rockets and cyanide, it is worthwhile to briefly describe several of the organization's other weapons innovations.

Like many U.S. domestic right-wing extremists, the CSA succeeded in assembling an impressive collection of explosives and commercially available firearms. For example, when federal agents raided the CSA compound in April 1985, they confiscated 38 handguns, 16 shotguns, 74 assault weapons and various rifles, together with over 183 large boxes of ammunition.[10] In terms of explosives, various reports assert that the CSA possessed 86 packs of binary explosives, up to 4,000 feet of detonation cord, 320 blasting caps, fifty sticks of dynamite and anywhere between one-and-a-half and 240 pounds of C-4 and C-3 explosives.[11]

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[9] Several commentators have observed that, even though the CSA's large-scale attacks were mostly unsuccessful, the group may have spawned a deadly legacy. They suggest that the CSA's aborted 1983 plot to destroy the federal building in Oklahoma City was finally completed by Timothy McVeigh on 19 April 1995, the very day on which Richard Wayne Snell, a member of CSA and a convicted murderer, was put to death (Michael Barkun, 'Religion, Militias and Oklahoma City: The mind of conspiratorialists', *Terrorism and Political Violence*, 8:1 (1996), pp. 57-58). According to a prison official, Snell had 'repeatedly predicted that there would be a bombing or an explosion on the day of his death' (Howard Pankratz, 'Blast Blamed on Revenge Attack Linked to Militant's Execution', *Denver Post* (12 May 1996), p. A-1, cited in Jessica Stern, *Terror in the Name of God: Why Religious Militants Kill* (New York: HarperCollins Publishers Inc., 2003), p. 29).

[10] Noble, p. 222

[11] Noble, p. 222; No author listed, *Declassified Memorandum on the Covenant, the Sword and the Arm of the Lord* (Originating agency unidentified) dated 20 May 1985, Declassified on 28 September 1989, p. 2; Hamm, p. 107.

However, as seen in Table 7.1 below, the CSA did not stop there, but put substantial effort into acquiring less common weapons, modifying those weapons it already possessed and producing its own improvised versions. Of particular note is the CSA's ability to fabricate various improvised explosive devices (in addition to those listed in the table, federal documents mention twenty-five unspecified 'destructive devices', at least one of which was referred to as a boobytrap)[12] and machine existing firearms.[13] Nor were the CSA's innovations limited to weapons adoption; group members at least attempted to engage in some attacks that were, for the domestic American context, quite tactically innovative. Chief amongst these was an attempt by three CSA members on 2 November 1983 to rupture a natural gas pipeline where it ran across the Red River in Fulton, Arkansas, using 23 sticks of dynamite.[14] The pipeline is a major source of natural gas for the Midwest[15] and the ostensible goal was to disrupt supplies and spark violence in major cities.[16] Although 'substantial damage'[17] was done to the pipeline, gas supplies were not interrupted.

Table 7.1: CSA Weapons Innovations

Weapon	Estimated Amount	Notes
Assault Weapon Conversion	Multiple instances reported	Precision machining of the parts of semi-automatic weapons to convert them into illegal, fully-automatic assault rifles.[18]
'Briefcase Bomb'	At least one produced	Timed improvised explosive device given to Kerry Noble to use in an attack on an adult bookstore.[19]
Improvised hand grenades	~40[20]	Declassified government documents describe 8 MK2-type ('pineapple') grenades, 2 M59-type ('baseball') grenades, and 12 'stick-type' grenades. Grenades were reportedly made by filling dummy grenades with C-4 and dynamite.[21]

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12 *Declassified Memorandum*, p. 2; Indictment, *United States of America v. James D. Ellison et. al.* (CR85-20017), U.S. District Court, Western Arkansas District, Fort Smith Division, p.9.

13 A quintessential example is the rather complex set of modifications made by Randall Rader, then CSA's military chief, to an Ingram MAC-10 machine pistol, a weapon that was subsequently used by the Order in assassinating Alan Berg and that Mark Hamm asserts 'eventually became legendary among right-wing activists of the era' (Hamm, p.95). In order to convert it to a lethal close-range automatic weapon capable of firing more than nine hundred rounds per minute, Rader 'added a takedown pin, [and] enlarged the bolt handle', while the CSA's chief weaponeer threaded the short barrel for a silencer (Ibid.).

14 Affidavit of Special Agent Jack D. Knox, *United States of America v. Stephen Scott* (CR85-20014), U.S. District court, Western District of Arkansas, Fort Smith Division.

15 Smith, pp. 64-65.

16 According to Kerry Noble, 'It was winter. We thought people would freeze, that they might start riots' (quoted in Stern (2003), p. 27).

17 Affidavit of Special Agent Jack D. Knox, *USA v. Scott*.

18 Rosenfeld, p. xiii.

19 Noble, p. 172.

20 *Declassified Memorandum*, p. 2.

21 Indictment, *USA v. Ellison et. al.* (CR85-20017), p. 9; Affidavit of Jack D. Knox, *United States of America v. James D. Ellison and William Thomas* (CR85-20006), U.S. District court, Western District of Arkansas, Fort Smith Division, p. 5.

Homemade Silencers	Unknown, at least 6[22]	Several of these were later used by other groups during assassinations, such as the Order's murder of Alan Berg. Those made by Kent Yates were reportedly described by an Alcohol, Tobacco and Firearms agent as being better than those made by the government.[23]
Landmines	~15[24]	The majority were home-made, 'Claymore-type' mines.[25] At least one mine on the main road to the compound could be detonated by remote control from the radio room.[26] Most, if not all, of the perimeter landmines detonated prematurely, according to Kerry Noble as the result of a lightning strike.[27]
Armoured Personnel Carrier	1, unfinished	In March 1985, construction began on an armoured vehicle with thick steel plates atop the chassis of a truck, to which the anti-aircraft gun would be mounted.[28]
LAW (light anti-tank weapon) Rocket	1 operational[29]	M72 version, firing high-explosive 66mm anti-tank rounds.[30] Hidden in the guttering of James Ellison's house.[31]
Anti-Aircraft Gun	1	World War II-era .303 calibre Lewis machine gun.[32]
Anti-Aircraft 'Rockets'	4	Apparently these consisted of reworked military popflares.[33]

Cyanide

When they conducted their search of the CSA property near Bull Shoals Lake in April 1985, federal agents made an unexpected discovery – a thirty gallon (113.6 litre) drum of potassium cyanide.[34] Further investigation revealed the disturbing designs that the group had for the poison, which were to contaminate the water supplies of large U.S. cities. Kerry Noble later admitted that, 'The purpose of the cyanide was so that in the future, when the judgment time had arrived, we could dump the cyanide into the water supply systems of major cities, condemning hundreds of thousands of people to death for their sins'.[35] The CSA had reportedly been given the cyanide precisely for this purpose by Robert Miles, a prominent leader of the Ku Klux Klan and head of 'the Mountain Kirk' in Michigan, while teaching a survivalist seminar in Detroit in the summer of 1981.[36] The CSA therefore adopted the weapon in the sense that they

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22 Stern (2003), p. 10.
23 Noble, p. 172.
24 Noble, p. 196.
25 Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p.5.
26 Smith, p. 63.
27 Noble, p. 196.
28 Noble, p. 194; Hamm, p. 109.
29 A witness, Gary Anderson, reported seeing an additional empty LAW rocket (Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p. 4).
30 Indictment, *USA v. Ellison et. al.* (CR85-20017), p. 10.
31 Noble, p. 221.
32 Noble, p. 222.
33 Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p. 9.
34 Indictment, *United States of America v. Robert Edward Miles et. al.* (CR87-20008), U.S. District court, Western District of Arkansas, Fort Smith Division, p. 21.
35 Hamm, p. 100; Noble, p. 288.
36 Noble, p. 121.

decided to retain the cyanide they had been given and even made plans for how to use it. Fortunately, the CSA's lethal ambitions were unrealizable given technical constraints on the use of cyanide for this purpose, since the dilution factor alone, not to mention water treatment procedures in major cities, would have rendered the poison harmless to the drinking public.[37] However, the CSA did succeed in harnessing the deadly effects of cyanide on a smaller scale, by sealing the poison in the tips of hollow-point bullets, so that any wound inflicted by them would likely be fatal.[38]

Rockets

As part of a CSA plot to bomb a federal building, a plan was devised in October 1983 whereby CSA operatives would park a van in front of the Murrah Federal Building in Oklahoma City and a timed detonating device would launch rockets at the building.[39] After James Ellison, Richard Snell and a third member, Steve Scott, travelled to Oklahoma City and posed as maintenance workers in brown uniforms for the purposes of determining the building's vulnerable points and what would be required to blow it up, Ellison decided to proceed with the plan and instructed Kent Yates, the CSA's armaments coordinator, to produce the rockets.[40] Yates began preparing and testing rockets[41] for the attack in late November or early December 1983.[42] During the development process, however, a misfire occurred and a rocket exploded in Yates' hands, badly injuring them. Yates was unable to continue, but rather than designate another member to take over the project, the rocket development initiative was abandoned. Kerry Noble, in many respects Ellison's second-in-command, recalls that, 'It was interpreted as a sign from God that another plan was to be implemented'. He adds that, 'Had God not intervened, I believe CSA would have begun its war against the government with an attack on the federal building at that time'.[43] In addition to this development, the CSA reportedly had acquired at least one working LAW rocket (see

[37] For an in-depth, yet non-technical, discussion of these issues, see Peter H. Gleick, 'Water and terrorism', *Water Policy* 8 (2006), pp. 481–503, esp. p. 487.
[38] Noble, p. 121.
[39] Hamm, p. 103, citing Jo Thomas and Ronald Smother, 'Oklahoma City Building was Target of Plot as Early as '83, Official Says', *New York Times* (20 May 1995).
[40] Hamm, p. 103; Noble, p. 158.
[41] Although the type of rockets sought is not mentioned in any sources, the most likely type is either a line-of-sight base-propelled charge (akin to a rocket-propelled grenade) or a mortar, based on the descriptions of the plan (in Ibid.), which was to park a van some distance away from the building and launch the rockets using a timed device from there.
[42] Hamm, pp. 104-105.
[43] Noble, pp. 158-159.

above), although the source of this is unknown. However, a single weapon is not regarded as constituting an achieved ‘rocket capability’, at least not for the purposes of standoff destruction of a major building intended by the CSA.

Following a description of the weapons with which the CSA innovated, we can now turn to how they went about doing so. Although not much more is known specifically about the process by which the group engaged with rockets or cyanide beyond that noted above, it is possible to infer several salient aspects of the process from more general knowledge of CSA operations.

a) *Equipment and Materials*: The locus of all the CSA’s weapons development was its compound, with no record of any such activity beyond the borders of its property. In keeping with its survivalist mentality, the CSA ensured that its compound, while remote, had its own water and electricity supply,[44] as well as sufficient food and other supplies to last for months, if not years.[45] This ensured that it could undertake its weapons development activities without reliance on or observation by any outsiders. Within the compound, the core location for weapons modification and fabrication was a well-equipped machine shop located in the basement of one of the buildings on the CSA property.[46] The machine shop reportedly included a lathe, drill presses, a milling type machine[47] and ‘the best tap and die equipment’.[48] It is highly probable that the equipment used in the pursuit of a rocket capability and for filling the cyanide bullets, was to be found in the machine shop. As for the sources of weapons materials (aside from the obvious gift of the cyanide discussed above), it is unclear exactly where the CSA obtained all of their explosives (or the LAW rocket for that matter), but they purchased many of the stocks of weapons that they would later modify at gun shows in Arkansas and Missouri.[49] The group also had contact with Robert Smalley, a weapons dealer who supplied right-wing extremist groups such as the Order with weapons.[50] They were not above outright theft, however; when a

[44] Coates, p. 136.
[45] Stern (2003), p. 10; Noble, p. 83.
[46] Stern (2000), p. 141, refers to ‘several factories’, but the author has found no other mention of any weapons production facility beyond the machine shop.
[47] Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p.3.
[48] Coates, p. 136.
[49] Hamm, p. 91.
[50] Smith, p. 64.

member, James Michael Morris, was discharged from the Marines, he stole military equipment from his Marine base for use on the compound.[51] Whatever their origin, these supplies likely provided a source of parts that could be cannibalized for use in the rocket program.

b) *Personnel*: CSA enjoyed a fairly high degree of technical and military competence. Overall coordination of weapons logistics, tactics and training initially fell to Randall Rader, who had joined the group in 1977 after several years engaged in drug use and the pursuit of rock stardom. Although possessing no formal military training, Rader threw himself enthusiastically into his new appointment as the organization's 'defence minister', becoming an avid reader of military manuals and related materials.[52] Rader spearheaded the conversion of semi-automatic weapons to automatic versions and was assisted by Rodney Carrington.[53] The bulk of the technical weapons development, however, was undertaken by Kent Yates, a former Green Beret in Vietnam with extensive training in weapons and explosives.[54] Yates, who has been described as 'a genius at his work',[55] would apparently remain alone in the basement workshop working on weapons for days at a time, only emerging for food.[56] Yates' abovementioned injuries no doubt had a negative impact on his ability to physically participate in weapons fabrication, but the CSA was deprived of even his expertise when, in the summer of 1984, Yates was arrested on an unrelated weapons charge while returning from a trip outside the CSA.[57] Not much is known about the adroitness or productivity of his purported replacement, Charlie Liddell, before the CSA was raided in April 1985.[58] The decision in 1978 by

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[51] Response of the United States of America to James D. Ellison's Motion for Reduction of Sentence (1988), *United States of America v. James D. Ellison* (CR85-20006-1 and CR85-20017-01), U.S. District court, Western District of Arkansas, Fort Smith Division.
[52] Hamm, p. 92. Apparently, he even taught himself how to decipher firearms manuals written in Chinese and German (Ibid.).
[53] Noble, p. 99. Noble stated that a member by the name of Hoyt Yearber took over the gun conversions after Rader and Carrington left CSA at the end of 1982 (Law enforcement interview with Kerry Noble, Baxter County Jail, Mountain Home, Arkansas on 22 April 1985, presented as evidence in *United States of America v. James D. Ellison and Kerry Noble* (CR85-20015), U.S. District Court, Western District of Arkansas, Fort Smith Division).
[54] Indictment, *United States of America v. James D. Ellison and Kent Yates* (CR85-20016).
[55] Noble, p. 171.
[56] Law enforcement interview with Kerry Noble.
[57] Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p. 6; Noble, p. 175.
[58] Affidavit of Jack D. Knox, *USA v. Ellison and Thomas*, p. 6; Report of Interview with David Giles (23 April 1985), presented as evidence in *USA v. Ellison et. al.* (CR85-20017).

CSA members to rid themselves of almost all electronic communications with the outside world (by destroying all the televisions and radios, except for those belonging to Ellison) may have had a dampening effect on the CSA's ability to work with electronic equipment. Nonetheless, the CSA did maintain a radio communications room and there is circumstantial evidence that they were able to retain some electronics expertise. A fugitive who came to CSA at the beginning of 1985, Peter Bjerke, reported that a man named John Kennedy had performed repairs on the radio equipment, and was, incidentally, paid with burglarized electronic devices, such as CB radios and portable televisions. Kennedy had reportedly lived at the CSA for three weeks in 1981.[59]

As in the previous case studies, it is useful for analytic purposes to separate the CSA's weapons development into discrete phases that can be evaluated separately. After reviewing the CSA's overall chronology, a logical categorization of their weapons adoption activity is formulated as follows:

1. *Building a Better Community* (1976 to July 1978): This phase covers the founding of the Zarephath-Horeb Community and the period of austere isolationism during which there was no weapons procurement or development.
2. *Ideological Metastasis* (August 1978 to 1982): This period witnessed the increasing militarization of the organization, first through adoption of a pre-millennialist outlook and then the white supremacist doctrine of Identity, culminating in the name change to CSA. It ended with the organizational split in December 1982, when Rader and many others left the organization. During this period CSA acquired the cyanide from Miles.
3. *On a Warlike Footing* (1983 to April 1985): Engaging in intense operational activity throughout this period, CSA attempted ambitious mass-casualty and mass-disruption attacks, including the development of rockets capable of destroying a large building.

Utilizing this framework, it is now possible to explore the factors affecting CSA's decision making with respect to weapons adoption and the outcomes thereof.

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[59] *USA v. Ellison et. al.* (CR85-20017), p. 8; Report of Interview with David Giles.

Innovation Awareness

Cyanide

It is unclear whether CSA was aware of the potential for cyanide to be used as a weapon before Robert Miles bestowed the toxic chemical upon them in 1981, but the circumstantial evidence argues strongly against this. There are no direct reports in any of the insider sources of any conscious organizational awareness of cyanide's potential as a weapon before 1981.[60] One should consider, however, whether there were any readily-available historical precedents that could have drawn their attention towards the utility of using cyanide as a mass-casualty poison through the water supply.

Ensconced as they were in the right-wing extremist milieu by this time, the organization's members were no doubt exposed to many of the contextual narratives and tropes prevalent during the period, including past exploits of militant actors and works like the *Turner Diaries* by Dr William Pierce, leader of the National Alliance.[61] To begin with the latter, the *Turner Diaries*, while brimming with weaponry and acts of destruction of all types (including large-scale nuclear weapons use), has only the briefest and vaguest of references to 'chemical weapons' in its conclusion.[62] With respect to actual occurrences, the only candidate cases that occurred prior to this time in the U.S. and that might have served as a model for using cyanide to cause mass casualties are those of R.I.S.E, an idiosyncratic right-leaning group that plotted to destroy humanity by poisoning the water supplies of major cities,[63] and the

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[60] These include Kerry Noble's autobiography of his time with the CSA and the testimony of numerous witnesses at various trials related to the organization's activities.

[61] The *Turner Diaries*, published by Pierce under the pseudonym Andrew MacDonald in the 1970s, has been referred to by the FBI as the 'bible of the racist right' (Camille Jackson, 'The Turner Diaries, Other Racist Novels, Inspire Extremist Violence', *Southern Poverty Law Center Intelligence Report*, 115 (Fall 2004)). The novel details the exploits of one Earl Turner, who is part of a white supremacist revolution against the United States government in the 1990s. In the book, Pierce graphically describes a wide range of violent attacks against blacks, Jews, government officials and others, ultimately ending with a victory for the rebels after using nuclear weapons to decimate their enemies (Andrew MacDonald (aka William Pierce), *The Turner Diaries* ([Place of Publication Not Listed]: National Vanguard Books, 1978), downloaded from http://www.jrbooksonline.com/PDF_Books/TurnerDiaries.pdf on 19 November 2012).

[62] MacDonald (Pierce), *The Turner Diaries*, Epilog [page numbers unavailable in downloaded version; chapter where material appears is indicated]. Although Morris Dees maintains that water supplies are poisoned in the novel (Morris Dees with James Corcoran, *Gathering Storm: America's Militia Threat* (New York, NY: Harper Perennial, 1997), p. 139), the author has not been able to find anything of this nature anywhere in the text.

[63] W. Seth Carus, 'R.I.S.E.' in Tucker (ed.), *Toxic Terror*.

Weathermen, who reportedly planned to likewise contaminate Lake Michigan (which was much-publicized) or New York City's Kensico Reservoir.[64] Yet, none of these plots involved cyanide: the R.I.S.E. plot involved biological agents and the Weathermen ostensibly contemplated using LSD or nerve agents. In any event, the applicability of anything the left-wing Weathermen had done as a model for emulation by Identity Christians is problematic.

Therefore, given the lack of any direct evidence and the scant repertoire of prior cases that could have served as demonstrations of cyanide's use as a weapon, it is likely that the first time Ellison and the CSA's other leaders became aware of the possibility of adopting cyanide as a weapon was when they were presented with substantial quantities of the substance itself.[65] The mechanism of awareness can thus be categorized as one of proselytization by an opinion leader within the broader movement.

Rockets

How did rockets come to the attention of Ellison and his operatives? Here, there are several likely routes. First, in a broad sense, the CSA had, by 1980 at the latest, become steeped in the survivalist context, which is preoccupied with conventional weapons of all kinds. Visits to gun shows and scrutiny of survivalist publications no doubt resulted in CSA members' exposure to discussions about a wide range of weapons, possibly including rockets. Second, and more specifically, Randall Rader consumed as much military literature as he could lay his hands on, including military manuals from around the world. It is indeed unlikely that he would *not* have come across numerous references to rockets of all types, from mortars to rocket-propelled grenades (RPGs). These could have been readily shared with James Ellison, the CSA's 'General'[66] and its ultimate arbiter of military decisions, who might then have drawn upon this information when contemplating his attack on the Murrah Federal Building. Third, even if Rader had not shared any substantive information about rockets with Ellison, Kent Yates had taken

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[64] Richard C. Clark, *Technological Terrorism* (Greenwich, CT: Devon-Adair Pub, 1980), pp. 110, 113. With respect to LSD, in 1968 the Weathermen reportedly threatened to 'space-out' attendees to the Democratic National Convention.

[65] Adding weight to this conclusion is the revelation that the CSA did not consider the use of biological weapons (another type of 'exotic' agent), apparently because no one in the organization had any knowledge of them (Stern (2000), p. 156).

[66] Noble, p.81.

over as the munitions expert by 1983 and, based on his extensive military experience, would no doubt have been able to suggest the rocket option to Ellison. Last, once the CSA had adopted the mantle of Christian Identity, its leaders were almost certain to study with great care the exploits described in the *Turner Diaries*, which had recently been published (in serialized form in the mid-1970s and in paperback in 1978) and was generating a large amount of excitement in far right circles. Unlike the case with chemical weapons, various kinds of rockets, primarily mortars, are prominently depicted in the novel. The novel's characters successfully utilize mortars and other types of rockets in several spectacular attacks, including an assault on the U.S. Capitol, downing an airliner filled with Jewish passengers,[67] destroying the Israeli embassy, and delivering radioactive contaminants to a power plant.[68] In fact, the book's protagonist, the eponymous Earl Turner, declares mortars to be 'incomparable'[69] and 'marvellous little weapons, especially for guerrilla warfare'.[70] Thus, while it remains uncertain exactly how the CSA became aware of rockets as a means of warfare, it can safely be said that all of the routes to awareness were intimately connected to the increasing militarization of the organization from 1979 on.

The Adoption Decision

People and Process

Before turning to the factors that prompted the CSA to pursue rocket technology and contemplate a mass-casualty cyanide attack, it is necessary to explore the decision-making structure and process that prevailed at the time of the adoption decision. Beginning with the decision structure, it quickly becomes evident that James Ellison was the primary decision maker for almost the entire period of the CSA's existence. According to Smith, 'There was no disputing his leadership'.[71] Although there was nominally a group of five or six 'elders' who directed the community's affairs (including, most prominently, Kerry Noble, Randall Rader and William Thomas), as

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[67] Macdonald (Pierce), Chapter 9.
[68] Macdonald (Pierce), Chapter 17.
[69] Macdonald (Pierce), Chapter 17
[70] Macdonald (Pierce), Chapter 9.
[71] Smith, p. 63.

founder and spiritual leader Ellison allotted himself two votes and dominated most decisions.

Ellison would on occasion delegate authority to trusted lieutenants in some areas of the organization, yet would brook no direct challenge to his primacy. An episode which illustrates this occurred in 1979, when he left the compound for several months to find outside work and left Randall Rader in charge. Rader quickly became dictatorial to the point of caricature, carrying a small whip and wearing a monocle, and tried to initiate a power struggle by spreading rumours of Ellison's impending demise.[72] He moved to shift the community towards a more militaristic posture, initiating the practice of converting firearms into fully-automatic mode. When Ellison returned, he took back the reins of power, castigating Rader, but decided to retain the illegal weapons anyway. The dissension between Rader and Ellison continued, exacerbated by Rader's blaming Ellison for his daughter's accidental death.[73] Ellison's steadfast refusal to desist from his plans to take a second wife was the last straw for Rader and those who supported him. This precipitated a split in the organization in December 1982, during which Rader and several dozen others left the compound and the CSA for good.[74]

Described as a 'spiritual entrepreneur'[75] who built his beliefs syncretically, one dominating aspect of Ellison's personality was a narcissism that bordered on megalomania. Ellison appears to have honestly believed that he had been chosen by God to lead his community through trial and tribulation. This belief was fed by his seemingly miraculous recovery from an accident in 1970, after which he declared that, 'God had to collapse a building around me and kill me so He could get my attention. … He brought me back for a purpose. His purpose!'[76] After a similar incident in 1978, when his young son was accidentally run over with a car by a member of the commune and emerged relatively unscathed, Ellison disclosed to Noble that, 'I know that I am set apart for God; but more importantly, my family is set apart for God also… I knew

[72] Noble, pp. 98-99. Rader also apparently swung a double-edged sword against a post during prayer services one night and threatened to replicate his actions on another member's head (Hamm, p. 92). He even claimed to have killed and eaten his own dog raw to demonstrate his commitment to survivalism (Hamm, pp.95-96).
[73] Noble, p. 118.
[74] Noble, pp. 108, 118, 140-141.
[75] Rosenfeld, p. xix.
[76] Noble, p. 28.

Joseph wouldn't die; no one will ever die here, as long as we trust Jesus and do what is right in His own sight'.[77]

Ellison's self-belief was buoyed by his confidence in his own prophetic abilities and only expanded over time, with Ellison first viewing himself as being without sin and then coming to believe that he was the embodiment of the biblical David, whose word was God's word.[78] His messianic traits reached their zenith when Ellison, in all earnestness, had himself crowned as 'King James of the Ozarks' in December 1983. These delusions of grandeur arguably were associated with Ellison being extremely risk prone. Examples include when he got caught shoplifting in Fort Smith, Arkansas and laughed at the incident, or, when facing the FBI lead hostage negotiator in April 1985, Ellison chewed on poison ivy leaves 'to demonstrate how extraordinary he was'.[79] It also allowed him to legitimize any behaviour that he could attribute to divine will, from polygamy to theft and, ultimately, to mass murder.

What Ellison did not want for was charisma, and this formed the basis of much of his authority.[80] 'Keith', an unidentified former government agent who infiltrated the CSA, maintained that 'I can tell you right now, if he walked from where he is into the next state, he would gather a lot of followers'.[81] Ellison's impassioned preaching and claims to prophetic insight allowed him to hold sway over his flock and direct their behaviour, as when, deciding in 1978 that the members should give up their individuality, he instructed the men to shave their beards and cut their hair short, which was symbolic of shedding their previous rebelliousness, as well as decreed that the entire community pool their financial resources and burn all reminders of their time prior to joining the CSA.[82]

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[77] Noble, p. 49.
[78] Noble, pp. 110, 131. In the face of authority Ellison did not always make such majestic claims – during testimony before a Grand Jury in September 1984 in relation to a weapons charge investigation (in which he was not a suspect), in answer to a question about his profession, he declared that he was a 'woodcutter' (Grand Jury Testimony of James Ellison (Sept 26, 1984), reproduced in Indictment, *USA v. Ellison and Thomas* (CR85-20006)).
[79] Danny Coulson and Elaine Shannon, *No Heroes: Inside the FBI's Secret Counter-Terror Force* (New York: Pocket Books, 1999), p. 299, cited in Rosenfeld, p. xiv.
[80] Kendall, Murray and Linden encapsulate Max Weber's notion of charismatic authority as 'power legitimized on the basis of a leader's exceptional personal qualities or the demonstration of extraordinary insight and accomplishment, which inspire loyalty and obedience from followers'. See Diana Kendall, Jane L. Murray and Rick Linden, *Sociology in Our Time* (Scarborough, ON: Nelson, 2000), pp. 438-439.
[81] Quoted in Stern (2003), p. 13.
[82] Noble, p. 52; Stern (2003), pp. 15-16.

At least in the early years in the commune, much of the source of this charismatic authority appears to have derived from the fact that Ellison was, in style if not in substance, less of the autocratic leader so often seen at the head of isolated, fringe religious communities. He relied more on patient persuasion to inculcate loyalty and bring his followers around to his way of thinking. For example, during Kerry Noble's early years in the community, Noble would often preach against Ellison's doctrine and Ellison tolerated this for several months until Noble eventually accepted Ellison's teachings.[83] In this regard, Rosenfeld states that, 'Ellison won devotion from followers by allowing them to think for themselves, while impressing them with his extraordinary gifts'.[84] At other times Ellison would badger his followers to get his way, for example, repeatedly telling William Thomas that 'God has shown me in a vision that you are to carry the sword of war for our group. You are to be the leader of these road trips'.[85]

As time wore on, however, Ellison seemed to become more outwardly despotic[86] and less tolerant of dissension,[87] to the point where during the federal siege of the CSA property, Ellison declared that, 'anyone who walks down that hill to surrender, I'll shoot them in the back myself!'[88]

The other side of the coin of any charismatic leadership is the attachment of the followers. During the early years of the group (at least until 1982), most of the members were genuine religious seekers in their twenties, striving for a better way of serving God and raising their families. Increased isolation from the broader American society led them to become more susceptible to Ellison's peculiar teachings and more dependent on the CSA community for both their spiritual and physical well-being. This in-group affinity gave way to the well-documented social psychological process of polarization

[83] Noble, p. 46.
[84] Rosenfeld, p. xxi.
[85] Noble, p. 165.
[86] In the context of the organizational split at the end of 1982, Noble observed that, 'Even though Ellison was in charge, in times past if the other elders overruled him on an issue, he would submit to us. Now, for the first time, the votes of the elders meant nothing to Ellison. For the first time in our church, Ellison's "revelation" was more important than the counsel of the elders – more important than the basis of our ministry. Now, we had reverted to the "one-man ministry"' (Noble, p. 145).
[87] When Noble questioned some of Ellison's decisions in early 1985, Ellison issued a stinging challenge: 'We will both plead our cases before God, right here, right now, and believe that He will answer before all these witnesses who He honours amongst us. Decide this day, Kerry, who will serve!' (quoted in Noble, p.195), after which Noble acquiesced.
[88] Noble, p. 9.

and out-group hostility, as the outside world came to be seen as populated by a multitude of threats.[89] As is common in such cases, the process was reinforced by rituals, as exemplified in the following recollection by Kerry Noble: 'The men made a pact one night during a weekly military meeting to serve each other, to serve our military commanders, to serve God's army and that any traitors or deserters during battle would be shot in the back. Each man passed through an archway made by the raised weapons of the other men'.[90] Loyalty to the group and to Ellison in particular as the embodiment of the group's will became a driving force in members' lives – to the extent where, after being accused of betrayal by Ellison for suggesting that the group abandon violence, Kerry Noble was willing to engage in mass-casualty violence by planning to bomb an adult bookstore in order to prove his loyalty. 'My desperation to earn a place in Ellison's kingdom now out-weighed any value for human life', he recalls.[91] While differing in some important respects from the coercive control often associated with religious cults[92] – most importantly, CSA members were allowed to come and go as they pleased from the settlement – the deindividuation, polarization, and charismatic leadership aspects of the CSA were reminiscent of a long line of insular groups, from the Manson Family to Aum Shinrikyo, that ultimately turned malignant and resorted to violence. In addition, as time wore on, most of the new recruits appeared to be more interested in CSA's militarism than its spiritual message, as Noble eventually came to realize: 'I sighed. Nothing about God, Jesus or the Bible. Nothing about love of the brethren. Guns and war. That's all he wanted. That's all anybody wanted who moved to CSA now'.[93]

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[89] Jerrold M. Post, Kevin G. Ruby and Eric D. Shaw, 'The Radical Group in Context: 1. An Integrated Framework for the Analysis of Group Risk for Terrorism', *Studies in Conflict & Terrorism*, 25:2 (2002), pp. 93-94; Daniel J. Isenberg, 'Group Polarization: A Critical Review and Meta-Analysis', *Journal of Personality and Social Psychology*, 50:6 (1986); Albert Bandura, 'Mechanisms of Moral Disengagement', in Walter Reich (ed.), *Origins of Terrorism: Psychologies, Ideologies, Theologies, States of Mind* (Washington, D.C.: Woodrow Wilson Center Press, 1998).

[90] Noble, p. 91.

[91] Noble, p. 171.

[92] There is significant scholarly controversy over the definition and usage of the term 'cult', with pejoratively labelled 'cult-bashers' and 'cult apologists' lining up on opposite sides. This study intentionally attempts to remain outside this debate by being judicious in its use of the term 'cult' as applied to the CSA. For more on the wider debate, see Benjamin Zablocki and Thomas Robbins (eds.), *Misunderstanding Cults: Searching for Objectivity in a Controversial Field* (Toronto: University of Toronto, 2001) and Jeffrey M. Bale, 'The Cult Wars, Part I', *Hit List Magazine* 2:4 (November-December 2000), pp. 80-85.

[93] Noble, p. 128.

Taking into account Ellison's domineering cult of personality and the dynamics of the organization by 1981, it is clear that all important decisions rested with him. Although other parties, like Rader and Snell (as we will shortly see) could take the initiative and make suggestions as to the direction of military matters, the final arbiter of the decision whether or not to adopt either cyanide or rockets was undoubtedly James Ellison.

Influencing Factors

Ideology

Underpinning the decision to adopt rockets and cyanide for use in indiscriminate attacks was a tacit embrace of the legitimacy of killing large numbers of human beings. Without the acceptance that such attacks were morally justified, Ellison and the CSA would never have pursued either of these weapons. To understand this position and how it served as the basis for adopting both weapons under discussion, it is thus necessary to examine the ideology of the CSA at the time of their adoption decisions.

As noted in the introduction to this case study, CSA's ideology evolved over time, initially focused on merely seeking refuge from a corrupt society while awaiting divine judgment[94] and then taking on a more or less apolitical Christian survivalist orientation, in which members prepared to survive the imminent catastrophe. However, after Ellison and others encountered and became influenced by such anti-government advocates as John Todd and Jack Mohr, they began to incorporate more conspiratorial thinking into their existing doctrine.[95] The final step towards full acceptance of the Identity doctrine in late 1979 came after Ellison drew close to Dan Gayman's Church of Israel and later Pastor Robert Millar, who ran Elohim City.[96]

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[94] Rosenfeld, p. xvii; Hamm, p. 90.
[95] Noble, p. 81-82, 93-94.
[96] Kevin Flynn and Gary Gerhardt, *The Silent Brotherhood: Inside America's racist underground* (New York: Free Press, 1989), p. 257.

While a full accounting of Christian Identity and millenarian thought is beyond the scope of this study,[97] some of the aspects most salient to the variant adopted by CSA are listed below:[98]

a. *'Two-seedline' racist theology*: A central tenet of Identity doctrine is that the white race (usually referring to those of northern European origin) are the true Israelites of the Bible, whereas the Jews are the spawn of Satan's congress with Eve. As such, Jews are *inhuman* agents of evil and an implacable enemy who has usurped the rightful position of the Aryan Children of Israel.[99] While not viewed as inherently evil, Blacks and other non-Whites are seen as inferior, *subhuman* races (often called 'mud people') that predated Adam and whose predestined role is to serve Whites.[100] When asked in 1984 how God feels when a Black man dies, Ellison replied, 'About like He does when a dog dies'.[101]

b. *ZOG and the secret plans for global control*: As part of the Jewish plan for world domination, which is well underway, the U.S. federal government and the mainstream media have been seized by a Jewish-led cabal that includes the Illuminati. The sacred Christian values and fundamental rights embodied in the American Declaration of Independence and Constitution are being trampled by the so-called 'Zionist Occupation Government' (ZOG), which will act quickly to eliminate any opposition. This global conspiracy is hidden from all but a few enlightened citizens.[102]

c. *Tribulation and Beyond*: A strong millenarian strain runs through Identity thought, which was in accord with CSA's previous beliefs of the coming 'End

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[97] See, *inter alia*, Michael Barkun, *Religion and the Racist Right: The Origins of the Christian Identity Movement* (Chapel Hill: UNC Press, 1994); Coates; Howard Bushart, John Craig and Myra Barnes, *Soldiers Of God: White Supremacists and Their Holy War for America* (New York: Kensington, 2000); and James Ridgeway, *Blood in the Face: The Ku Klux Klan, Aryan Nations, Nazi Skinheads, and the Rise of a New White Culture* (New York: Thunder's Mouth Press, 1995).
[98] This list is similar to that put forward in Michael Barkun, 'Millenarian Aspects of "White Supremacist" Movements', *Terrorism and Political Violence*, 1:4 (1989), pp.417-418.
[99] Michael Barkun has compared this notion to the political anti-Semitism of the nineteenth and early twentieth centuries and characterizes this as a 'redemonization' or 'retheologization' of anti-semitism (Barkun (1989), pp. 423, 425-426).
[100] Stern (2000), p. 142; *Hate Groups in America*, p. 53; Noble, p. 103.
[101] Noble, p. 171.
[102] As Barkun shows, the more such ideas are rejected by mainstream institutions, paradoxically the more credible they become for adherents of the doctrine, since this perpetuates their conception of a larger conspiracy (Barkun (1996), pp. 59-60).

Times'. As recounted in the biblical Book of Revelations and elsewhere, the coming of the latter days of Christ's Kingdom will be preceded by a period (often said to be seven years) of Tribulation,[103] during which the righteous would be assailed by evil hordes, led by false prophets and the Antichrist. An article in the group's own publication, the *CSA Journal*, described their view of the horrors to come:

> Russia and possibly China and Japan will attack America, probably with some limited nuclear warfare. Communists will kill white Americans and mutilate them; witches and satanic Jews will offer people up as sacrifices to their gods, openly and proudly; blacks will rape and kill white women, and will torture and kill white men; homosexuals will sodomize whoever they can. Prisoners from Federal and State prisons will be set free to terrorize, while Cuban refugees will do the same. Nowhere will be safe without the grace of God.[104]

One distinction between the Identity version of these events and the CSA's previous beliefs is that under Identity the coming conflagration will take the form of a race war against the Jews and their agents in ZOG, thus combining the political and religious conflicts mentioned above.[105] Most importantly, the CSA's leaders came to believe that not only did they need to prepare to protect their community during this time (a defensive posture), but that they could help usher in the end times – and the glorious kingdom of the risen Christ thereafter – by bringing the fight to ZOG, thus hastening an inevitable war in which the White race would ultimately prevail, so long as it took action (an offensive doctrine).[106]

The above beliefs, accompanied by an unhealthy dose of paranoia, combined into a dangerous cognitive mix: there was (a) a conflict of cosmic import that (b) had been divinely ordained, in which (c) human agency would be required against (d) a

[103] Noble, pp. 401-402.
[104] Quoted in *Hate Groups in America*, p. 51.
[105] Barkun (1989), p. 426.
[106] Stern (2000), p. 143. In an interview with Jessica Stern, Kerry Noble confided that 'We believed that once those signs were there, it was time for us to act, to make judgments against those who were doing wrong or who refused to repent…The original timetable was up to God, but God could use us in creating Armageddon. That if we stepped out, things might be hurried along. You get tired of waiting for what you think God is planning' (Interview 2 March 1998, cited in Stern (2003), p. 11). Randall Rader put it less elegantly when he declared in 1979 that 'I'm tired of waiting. If God doesn't start the riots soon and the collapse of our government, then I will!' (Noble, p. 98).

dehumanized enemy. This led to a mental state among at least certain CSA members by the early 1980s[107] wherein large-scale violence was not only a legitimate tactic in their struggle, but might indeed have become a moral imperative. In his interview with Jessica Stern, Noble asserted that 'There were certain people who would have done it [poisoned whole cities], could have done it with no problems. It could very easily have happened'.[108]

One last relevant aspect of CSA's ideology was its emphasis on prophecy. Like many fundamentalist Christian congregations at the time (but less so among Identity groups), CSA believed that any member sufficiently close to God could be a vehicle for prophecy. While Ellison revelled in the role,[109] it was not limited to him,[110] which would later prove consequential.

Cyanide

The most obvious influencing factor on the adoption decision was that the organization had been presented with the cyanide itself and would have had to take the conscious action of rejecting or disposing of it in order *not* to adopt it. The simplest explanation would thus be that invention (or in this case donation) became the mother of necessity.[111] However, the rationale likely goes far beyond this and is related to Ellison's and the CSA's relationship to the broader right-wing extremist movement. Subsequent to Ellison's adoption of Identity theology, the CSA rapidly rose to a position of prominence within the network of Identity churches, tax protestors and proto-militias that constituted the American far right scene at the time. Much of this was thanks to Randall Rader's skill in accumulating weapons and military knowledge and the CSA's decision – taken in order to supplement its income – to serve as a hub for

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[107] As part of bringing his congregation to this point, shortly after invoking Christian Identity doctrine, Ellison ordered every CSA member to sign a ' "Declaration of Non-Surrender", in which they vowed to fight to the death for Jesus Christ' (Hamm, p. 93).
[108] Stern (2000), p. 156. Stern contends that the CSA 'was unusual among terrorist groups in that its sole objective was large-scale murder rather than influencing government policies' (Ibid., p. 139).
[109] In fact, Ellison made numerous prophecies of the impending apocalypse, beginning in the late 1970s (Hamm, p. 93).
[110] Noble, pp. 26, 63. An example is when Ellison's first wife, in March 1985, prophesied: 'Behold the day of the Lord is at hand. I would that you would gird up your loins and be prepared for battle, says the Lord' (Noble, p. 195).
[111] Cf. the discussion in Chapters 2 and 3.

paramilitary training across the far right.[112] Ellison, spurred on by his narcissistic self-conception as a divinely chosen leader, eagerly stoked such perceptions, and by 1982 even had designs on being anointed as the leader of a united front of all the far right groups,[113] which included Robert Miller's Elohim City, Richard Butler's Aryan Nations, William Pierce's National Alliance, and of course, Robert Miles' Mountain Kirk. So, when an important leader like Miles thought enough of the CSA and its role in the struggle to offer them a new, potentially significant, weapon for the cause, Ellison likely also attached some degree of prestige to the event and would be loath to appear to be an ungrateful recipient before a key player in his constituency.

This was borne out by subsequent events. In the wake of the fatal shooting of Gordon Kahl, a tax protester, by law enforcement officers near the CSA compound, the far right was galvanized and held an infamous meeting at Aryan Nations in July 1983. During this meeting, several leaders, including Butler, Miller, Miles, Louis Beam and Ellison, allegedly hatched plans for an armed overthrow of the U.S, Government.[114] One of the key elements of this plot was allegedly the 'polluting of municipal water supplies' apparently in New York, Chicago and Washington, DC.[115] Incidentally, Ellison was the government's lead witness in a sedition trial that resulted from this meeting, which the government lost, at least partly because the jury believed that Ellison was merely testifying in order to reduce his sentence.

A further reason for adopting the cyanide is that the toxic nature of the substance itself, which could (at least in Ellison's mind) serve as a means of raining destruction on

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[112] Rader's pride and joy was 'Silhouette City', a training school complete with buildings, cars, and silhouettes of various law enforcement agents and Jewish personages, which was built to emulate the FBI's shooting range at Quantico, Viriginia (Hamm, pp. 95-96). It was here that Rader established the 'Endtime Overcomer Survival Training School', which taught weapons usage, military tradecraft and unarmed combat (*Hate Groups in America*, p. 51). The CSA also published a 174-page *CSA Survival Manual*, which became the primary training manual for the right-wing (Noble, p. 119), as well as selling a host of racist and anti-Semitic literature (see Stern (2000), p. 141 for several examples) and publishing their own journal with a distribution of two thousand people (Noble, p.119).

[113] Although Noble recalls explicitly suggesting this idea to Ellison only in August 1982 (Noble, p.127), given Ellison's penchant for self-aggrandizement, the prospect of playing some type of major role in the far right movement had no doubt occurred to Ellison even as early as 1981 when he received the cyanide. It was with the ulterior motive of being endorsed as leader of the far right that Ellison invited its luminaries to a CSA National Convocation in October 1982 and, although he did not win outright approval for leadership of a united right-wing extremist movement, his stature increased and by the end of the following year he had persuaded Robert Miller to crown him King of the Ozarks (Noble, p.129).

[114] Dees and Corcoran, pp. 44-45; Smith, p. 56.

[115] Indictment, *USA v. Miles et. al.* (CR87-20008); No author listed, 'Group Weighed Cyanide Assault, Witness Testifies', *Birmingham News* (23 February 1988), p. 6b; Response of the USA to Ellison's Motion for Reduction of Sentence (1988).

God's enemies on a large scale, appealed to the CSA's apocalyptic outlook. It could potentially enable the group, at the appropriate time, to escalate beyond the small-arms military manoeuvres that it had been training for, to an attack at a scale matching that of their ideology, as described above, which spoke of Armageddon and global conflict, and accepted no constraints whatsoever on the means involved.[116] At a less cosmic level, using cyanide as Ellison envisaged would also serve the general white revolutionary strategy, which entailed 'disrupting public services and creating general turmoil'.[117]

As for questions whether the group could successfully carry out such an attack, which would no doubt figure into any adoption decision, subjectively this did not present an obstacle. Ellison and the other CSA members merely took it on faith that, so long as they were following God's will, any venture employing the cyanide would be effective. When questioned about how they had envisaged countering the dilution factor or preventing Aryans who might drink the water from also being poisoned, Noble explained that 'God would… make sure the poison got to the town' and '…that those who were meant to die would be poisoned'.[118] Ultimately, while a cyanide weapon in particular was not strictly necessary to achieve the CSA's objectives, it fit in exceedingly well with the narrative of a personal and racial manifest apocalyptic destiny that Ellison propounded.

Rockets

At least part of the decision to adopt rockets as a CSA weapon likely stemmed from tactical exigencies surrounding the target for which they were developed – the Murrah Federal Building in Oklahoma City.[119] Given, first, that the intent was for the entire building to be destroyed, second, that the perpetrators needed to avoid detection and capture, and, third, that there is no mention of the CSA ever considering a suicide

[116] Kerry Noble has claimed that if Ellison had encountered an individual with biological expertise, he would consider using bioweapons (Stern telephone interview with Noble, 2 March 1998, in Stern (2000), p. 139).
[117] Response of the USA to Ellison's Motion for Reduction of Sentence (1988).
[118] Stern (2000), p. 151.
[119] Richard Snell was the person who recommended destroying a federal building to Ellison and who conducted the initial surveillance. In yet another alleged connection between Snell and the Murrah Federal Building, Mark Hamm suggests that the source of Snell's idea was a personal desire for revenge against the federal officials (in the Internal Revenue Service) who had impounded all of Snell's assets, left him in financial ruin and who just happened to work at the Murrah Federal Building (Mark Hamm, *Apocalypse in Oklahoma: Waco and Ruby Ridge revenged* (Lebanon, NH: Northeastern University Press, 1997), pp. 5-6).

attack, the alternatives in terms of weapons were limited to a bomb large enough to bring down the building from some distance away (the solution employed by Timothy McVeigh over a decade later), or a series of standoff projectiles.[120] Combining these considerations with the availability heuristic provided by the copious references to rockets in the *Turner Diaries* and it is little surprise that rockets would be favoured.

However, the greater uncertainties and resources required to develop and deploy rockets when compared with those required for a large truck-bomb imply that other factors were probably in play. It is argued that the pursuit of rockets was part of a broader pattern of operational innovation undertaken by the CSA in the latter part of 1983, which included arson at a gay-friendly church in Springfield, Missouri, the previously mentioned pipeline attack and attempts to bomb a synagogue and assassinate a judge. This frenetic series of attacks and attempted attacks was sparked by the 'martyrdom' of tax protester Gordon Kahl and the subsequent clandestine meeting of far right gurus in July 1983. After this meeting, Ellison – who had declared during the gathering that 'the sword is now out of the sheath' and that 'for every one of our people they kill, we ought to kill one hundred of theirs!'[121] – appeared to assume the role of vanguard of the anti-government struggle.[122] Indeed, with respect to his intended rocket attack, Ellison openly declared that 'We need something with a large body count to make the government sit up and take notice. I want to be able to launch these rockets from a trailer some distance away. And I want the government to know that the right-wing has spoken, that the Second American Revolution has begun'.[123] Ellison saw himself as one of the founding fathers of this Revolution[124] and using fairly sophisticated weaponry like rockets would both grab the attention of his enemies and bring him prestige within the movement.[125]

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[120] This assumes that, after their initial surveillance, they realized that smuggling a sufficiently large amount of explosives into the building was an impractical proposition.
[121] Noble, p. 154.
[122] During the same time period, Robert Mathews was doing much the same thing, albeit with a much lower profile and a different strategy.
[123] Noble, p. 158.
[124] Noble, p. 155.
[125] In late 1983, Ellison remarked to Noble that Louis Beam had given him the code name of 'Warlord' and that he intended to live up to that name (Ibid.)

In any event, as detailed above in the case of cyanide, using rockets to cause mass casualties was legitimate in Ellison's eyes, as demonstrated by the following exchange between Ellison and other CSA members regarding the rocket attack:

> Unidentified CSA member 1: 'Are there people in the federal building working there besides feds?'
> Ellison: 'Doesn't much matter. There are no innocents in war. Those people have chosen to work in a federal building'.
> Unidentified CSA member 2: 'What about the children? Will there be any children there?'
> Ellison: 'The sins of the fathers are visited upon the children'.[126]

Moreover, the use of rockets and the expected subsequent large casualty count also supported the CSA's overall strategy of large-scale disruption in order to defeat ZOG and initiate the end times.

In order for charismatic authority to persevere, it requires the sustained belief of the followers in their leader's exceptionalism. Following a series of negatively perceived events, by 1983 Ellison's hold over several members of his CSA flock had waned. These events included the death of Randal Rader's child in March 1981 on the ostensibly divinely protected compound, deterioration of living conditions, Ellison's brushing aside of superstitious concerns in 1982 regarding the shape of the new sanctuary, and his decision in late 1982 to take a second wife against the advice of the elders.[127] Another reason for Ellison's ramp-up in the intensity of his actions in the latter part of 1983 – including the pursuit of a complex weapon like a standoff rocket capability – might thus have been to galvanize his disciples and reinvigorate their allegiance to him and his vision. Moreover, many right-wing conspiracies point to technologies as the tools of the Antichrist,[128] and the use of higher level technology against the enemy might have been Ellison's way of 'fighting fire with fire'.

Finally, by this time Kent Yates had joined CSA and had proven himself to be technically adept with a variety of weapons and their fabrication. There had even been a prophecy by a young female member of CSA regarding Yates' value to the CSA.[129] In this context, Ellison most likely had a high degree of faith not only in Yates, but also

[126] Reconstructed from Noble, p. 158.
[127] See Rosenfeld, p. xxii; Noble, pp. 118, 135, 137; Flynn and Gerhardt, p. 258.
[128] Barkun (1996), pp. 55-57.
[129] Noble, p. 160.

that his plans were blessed by divine sanction and would thus succeed despite any technical hurdles.

Reasons for Adoption Success (or Otherwise)

The CSA did not succeed in adopting either cyanide or rockets as viable weapons, although they did manage to acquire, store and lace bullets with cyanide. The group did possess several organizational attributes often positively associated with successful weapons adoption. These included sufficient resources to fund R&D activities, an institutionalized R&D function (manifested in their machine shop) and a relatively undisturbed safe haven in that they possessed an isolated compound, as well as the time to develop at least some degree of proficiency (with respect to both *techne* and *mētis*) in modifying and producing firearms and basic explosives.

With respect to resources, the CSA had numerous sources of income, including legitimate labour such as timber logging, operating a health food store, and working on missile silos, as well as illicit activities such as shoplifting (referred to as 'plundering the Egyptians'), food stamp fraud, selling modified weapons and insurance fraud.[130] A major source of income was derived from their right-wing activities, i.e., their paramilitary training activities at Silhouette City and elsewhere and their sale of extremist literature.[131] These activities enabled them to spend an estimated $52,000 on weapons, ammunition and other military equipment during 1978 and 1979 alone.[132] Among the items confiscated during the April 1985 search of the CSA compound were 155 Krugerrands and numerous gold and silver coins.[133] It has even been alleged – although without corroboration – that the CSA at one time owned a gold mine in Costa Rica.[134]

[130] Flynn and Gerhardt, p. 257-8; Hamm (2007), p. 102
[131] Coates, pp.136-7; Smith, p. 63.
[132] Hamm (2007), p. 91.
[133] *Declassified Memorandum*.
[134] Coates, p. 68.

While several of these strengths were equivocal during certain periods – in particular their access to funding[135] and their isolation from security forces[136] – it might still be expected that they would have enjoyed somewhat greater success in their adoption efforts with respect to acquiring rocket capabilities or using cyanide as a mass-casualty weapon. Yet several significant organizational impediments stood in the way of adoption success, the most important of which are listed below for each weapon under investigation.

Cyanide

i) Lack of *techne* (let alone *mētis*): Of the chemical warfare agents, cyanide (as a toxic industrial chemical) is among the easiest to acquire – receiving the cyanide as a gift meant that the CSA did not even need to accomplish this step. Yet it is less toxic than many other chemical weapons, making efficient delivery mechanisms all the more crucial. While the group's members had some understanding of cyanide's capacity for harm (they knew enough to lock the barrel away from the children[137]), they lacked anyone with sufficient chemistry knowledge to understand the immense hurdles – namely dilution and treatment – in the way of successful dissemination of the chemical in a way that would cause mass casualties through the water supply.[138] As Kerry Noble admits, 'Back then there were no books on [chemical warfare], we didn't have the Internet, and we didn't really know what we could do with it [the cyanide]. We were ignorant on that kind of thing'.[139]

ii) Non-rational, ideologically driven tactical theories: As mentioned in connection with the decision to adopt, their lack of *techne* and *mētis* did not put a brake on their

[135] A downswing in the timber market, as well as Ellison's disdain for government, resulted in the compound being foreclosed upon on 20 December 1983 (Noble, p.177). It was saved from public auction only by a wealthy benefactor the following year.
[136] Unlike many classic cults, the CSA compound was not closed, and reportedly as early as 1978, federal agents had the compound under some level of observation (*Memorandum: SAC, Little Rock to Director, FBI* (24 August 1983), Declassified File No. 100-HQ-48720; Hamm, p. 107). However, neither the rocket plot nor the cyanide was discovered until 1985, so law enforcement infiltration could not have been a direct cause of their failure to adopt.
[137] Noble, p. 121.
[138] Stern cites a United Nations study that estimates the amount of potassium cyanide needed to contaminate an *untreated* reservoir at ten tons (United Nations General Assembly, *Report of the Secretary General on Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use*, UN Document A/7575 (1 July 1969), cited in Stern (2000), p. 154).
[139] Interview with Kerry Noble (16 December 2004), cited in Hamm (2007), p. 105.

aspirations. They believed that God would guide the cyanide through the water supply so that it reached only the evildoers in sufficient concentrations. This fantastic approach to tactical preparations apparently resulted in the CSA not even exploring the delivery requirements in detail, nor attempting to increase their technical knowledge or to recruit appropriate personnel.

Rockets

i) Ideologically-driven lack of perseverance: The CSA's intense belief in divine imprimatur and involvement in every aspect of their activities meant that when they encountered a setback, as with the misfire that injured Kent Yates during the development of the rockets, instead of viewing this as a common occurrence during any complex operation, they interpreted it as a sign of divine displeasure and abandoned the entire enterprise. This was not the only instance in which a plot was abandoned or the group's course changed by its sensitivity to the supernatural.[140] Possibly the most important of these was that it was apparently a prophecy on the part of Ellison's first wife that convinced him to surrender to authorities in April 1985.[141]

ii) Lack of operational depth: Again related to their spiritual beliefs, Ellison and the CSA put complete faith in Kent Yates' abilities, particularly after they had received a prophecy that he was the right man for the job. While Yates possessed a high degree of technical knowledge and was adept at modifying guns, he had less success with explosives (as seen not only with the rocket accident but also with the minimal damage done in the synagogue attack)[142] and thus may have lacked the requisite *mētis* in this area. Once Yates was out of the picture, there were apparently no other members with his degree of expertise to continue the project, even if they had wanted to. Among the likely reasons for this lack of depth in skilled personnel are the isolation from the outside world enforced in the compound (e.g., no access to television) and the overall decrease in the number of members – including those

[140] A similar reaction occurred when, on 26 December 1983, several CSA soldiers were on their way to assassinate a judge and federal agent, and they became involved in an automobile accident (Government's Pretrial Memorandum in *USA v. Miles et. al.* (CR87-20008)). This was again seen by the CSA that God had decided that the time was not right and the plot was abandoned (Noble, pp. 162-163).
[141] Rosenfeld, pp. xv-xvi.
[142] Hamm (2007), p. 102.

proficient with weapons – after Rader and at least half of the existing membership had left the CSA by the first few months of 1983.[143]

iii) Forced operational tempo: The latter part of 1983 witnessed a flurry of attacks and attempted attacks by the CSA. Although Gordon Kahl's death and the subsequent decision to take the fight to the government was the immediate catalyst, there were several other factors driving Ellison to rapidly increase the tempo of CSA violence. Especially pertinent was the aforementioned desire to reinvigorate his leadership of both the CSA and the broader far right movement in the wake of the split of 1982; indeed Flynn and Gerhardt aver that 'after Rader left, CSA went over the edge'.[144] There was also the factor of Ellison possibly believing that the prophesied Tribulation was finally at hand after several disappointments. Since 1978, Ellison had been predicting dates for the collapse of the United States and the initiation of the end times and each time the prophesied apocalypse had not occurred.[145] While this had in some ways only made his followers more dependent on him (a process described in the seminal work by Festinger, et. al.[146]), Ellison might have honestly believed that the time was finally nigh and that he had to do all in his power to seize the opportunity. In any event, moving from almost no terrorist attacks to several different missions being planned simultaneously, being plotted and carried out by a small subset of CSA members, must have put a tremendous operational strain on whatever capabilities the organization had built up over the previous years. It is little wonder then that most of these attempts, including the arson attack at the Metropolitan Community Church in Springfield, Missouri, the bombing of the Jewish Community Centre in Bloomington, Indiana and the attempted rupturing of the natural gas pipeline, yielded suboptimal results, if any tangible effects at all. The same phenomenon would also likely have infected the mission to develop rockets and destroy the federal building.

In short, most of the failure to effectively weaponize the cyanide or to achieve an in-house rocket capability can be attributed to Ellison's inherently superstitious world view

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143 Federal Bureau of Investigation, *Information on the Covenant, the Sword and the Arm of the Lord*.
144 Flynn and Gerhardt, p. 258.
145 Noble, p. 113.
146 Leon Festinger, Henry W. Riecken and Stanley Schachter, *When Prophecy Fails* (London: Pinter and Martin, 2008).

and narcissistic personality. The CSA's peculiar ideology, while a substantial inducement towards violence, was an impediment to the attainment of the means to carry out this violence. Interestingly, with regard to the two technologies under consideration here, the dynamic worked in opposite directions. In the case of the cyanide, it made the CSA overconfident in their abilities and thus precluded the necessary research and development from being undertaken, while in the case of the development of rockets, their ideology robbed them of their confidence and led to them abandoning the project, arguably prematurely.

Negative Case Study: The Order

For a brief period in the early 1980s, the Order, or Bruder Schweigen[147] as its members referred to themselves, engaged in a number of violent actions that secured the organization's place as one of the most vigorous domestic terrorist groups in United States history. Founded in Metaline Falls, Washington by the iconoclastic Robert Jay Mathews in late September 1983,[148] the Order drew on far right tropes and templates and sought to provide a nexus for those disparate extremists throughout the country who wanted to do more than just talk about overthrowing the government. Explicitly modelled after the exploits of a group in the *Turner Diaries* with the same name,[149] the Order's actions were predicated on defending the white race and triggering a war with the Zionist Occupation Government ('ZOG').

It lost little time in becoming active, conducting increasingly lucrative robberies in its first nine months (see Table 7.2 below). These climaxed in the armed robbery of a

[147] This name, which only came to be used in the last few months of the group's existence, was drawn from a verse in a German poem of 1814, which cautioned against the time '*wenn alle Brüder schweigen // und falschen Götzen traun* (when all our brothers are silent // and trust in false idols)' (Coates, p. 40). The group has thus also been called the 'Silent Brotherhood'.
[148] Flynn and Gerhardt, pp. 6, 96; Dees and Corcoran, p. 141. The grand jury indictment of the Order placed the organization's beginnings 'in or about October 1983' (Second superseding indictment at 4, *United States of America v. Bruce Carroll Pierce et. al.* (CR85-001M), U.S. District Court, Western District of Washington, Seattle Division).
[149] The 'Order' in William Pierce's novel is actually the elite leadership cell of a broader group called the 'Organization'. Mathews himself did not use the name 'the Order,' which was one of the many monikers used by members, but became the label appended to the group by authorities (and generally by scholars). In fact, Mathews did not name his group at all until September 1984, believing initially that this was more secure. A year after the group was created, he finally selected the name 'Bruder Schweigen' (Flynn and Gerhardt, pp. 140, 294).

Brinks armoured truck on a highway near Ukiah, California on 16 July 1984, which netted the group a tidy sum of $3.6 million.[150] At the time, this was the largest armed robbery in U.S. history, and Mathews used the loot to fill the coffers of the far right and expand the influence of his group, enabling him to set up a countrywide network of over fifty right-wing extremists.[151] Along the path to the Brinks robbery, the Order had also murdered one of its own[152] and attempted to bomb a synagogue,[153] before moving on to the assassination of prominent Jewish talk show host Alan Berg in June 1984.[154] The group had far more ambitious plans, and poured its resources into recruitment, training and planning large-scale attacks. However, primarily as a result of shoddy tradecraft on the part of its members, the Order was infiltrated by the FBI and other law enforcement agencies, which led to a deadly game of cat and mouse with authorities in the latter part of 1984.

Table 7.2: Summary of Major Criminal Activity by The Order[155]

Date	Criminal Activity	Notes
28 October 1983	Armed Robbery – Pornographic bookstore north of Spokane	Personnel: Mathews; Pierce; Duey; Bauer Amount: $369.10
From October 1983	Counterfeiting – $50 bills (later $10 bills)	Personnel: Lane; Yarbrough; Merki Used Aryan Nations' printing press before buying their own.
17 December 1983	Bank robbery – City Bank, north of Seattle	Personnel: Mathews Amount: $25,952 (covered in red security dye from exploding security device)
30 January 1984	Armed Robbery – Washington Mutual Savings Bank, Spokane	Personnel: Pierce; Yarbrough Amount: $3,600
16 March 1984	Armed Robbery – Continental Armoured Transport Service truck outside Fred Meyer store	Personnel: Mathews; Pierce; Yarbrough; Duey Amount: $43,345
23 April 1984	Armed Robbery – Continental Armoured Transport Service truck, Northgate Shopping Centre, Seattle	Set off bomb in Embassy Theatre (pornographic cinema) in Seattle the day before and used threat of another attack as diversion for robbery. No fatalities but police state that blast sufficiently powerful to kill. Personnel: Mathews; Parmenter; Barnhill; Pierce; Duey; Yarbrough; Kemp Amount: $534,000 (approx. $230,000 in cash)

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150 Smith, p. 70.

151 Although there were only nine members at its inception, Richard Scutari, a senior former member, asserts that by December 1984, the Order had '50 underground members and numerous legal above ground supporters' (Richard Scutari, quoted in Magnus Söderman, 'Interview with Richard Scutari', in Magnus Söderman and Henrik Holappa (eds.), *Unbroken Warrior: The Richard Scutari Letters* (Stockholm: Nationellt Motstånd Förlag, 2011), p. 113.

152 The Order executed Walter West in a deserted forested area in May 1984 because they believed that his drunken ranting would reveal their activities (Smith, p. 69; Flynn and Gerhardt, pp. 169-170).

153 Flynn and Gerhardt, p.157.

154 *United States of America v. David Lane, et al* (87-CR-114), U.S. District Court, District of Colorado, Denver Division; Coates, p. 67.

155 Sources: Smith, p. 69, 70; Hamm, p. 130; Stephen Singular, *Talked to Death: The Life and Murder of Alan Berg* (New York: Beech Tree Books, 1987), p. 206; Flynn and Gerhardt, pp. 123-124, 150-151, 157, 167-170; *Turning Point: The Order,* Documentary, American Broadcasting Corporation (ABC), 1995.

29 April 1984	Firebomb Attempt – Congregation Ahavath Israel Synagogue, Boise, Idaho	Personnel: Pierce; Kemp Bomb went off but minimal damage caused.
27 May 1984	Murder – killing of Walter West in Kaniksu National Forest, near Coeur d'Alene, Idaho	Personnel: Kemp; Dye; Duey; Tate
18 June 1984	Murder – Assassination of Alan Berg in Denver	Personnel: Mathews; Pierce; Scutari; Lane Pierce was the shooter, using Rader's modified MAC-10 from the CSA.
16 July 1984	Armed Robbery – Brinks armoured car, near Ukiah, California	Personnel: Most members took part Amount: $3.6 million
24 November 1984	Shootout with federal agents – Portland	Personnel: Mathews Fleeing a trap set by the FBI thanks to Tom Martinez, Mathews wounds a pursuing federal agent
8 December 1984	Shootout with law enforcement – Whidbey Island, near Seattle.	Personnel: Mathews Mathews died in ensuing fire.

Eventually, the group was tracked to Whidbey Island, near Seattle, where Robert Mathews was cornered and died in a fire during a standoff with law enforcement on 8 December 1984.[156] The remaining members of the Order who had escaped were pursued relentlessly;[157] almost all were apprehended within the following eighteen months and subsequently sentenced to lengthy prison terms. Robert Mathews and other well-known members of the Order soon rose to occupy the status of martyrs in the far right extremist movement worldwide, a status which persists even today.[158] The Order presented law enforcement with many innovations, particularly when compared with previous far right behaviour; however, despite possessing a similar ideology and having access to much of the same type of expertise as the CSA, its innovations were largely tactical and organizational in nature and did not involve the adoption of any major weapons, including rockets or cyanide.[159]

The Innovations

[156] Mathews refused to give up and had held dozens of law enforcement officers at bay for many hours by firing at them from the house where he was holed up. Eventually the decision was made to launch military flares into the house, which set it ablaze and resulted in Mathews – who still refused to emerge – dying in the fire (David Schaefer, 'Fiery FBI Raid End Whidbey Standoff', *Seattle Post-Intelligencer* (9 Dec. 1984), p. A1; Peter Lewis and Joni Balter, 'Whidbey Siege: Roles in a Book?', *Seattle Times* (10 Dec. 1984), p. A1).

[157] Several members of the Order actually fled to the CSA and took refuge on their compound in the early months of 1985. It was the murderous actions against a Missouri state policeman of one of the Order fugitives, David Tate, who was reportedly on his way to the CSA, that set in motion the chain of events which resulted in the federal siege of the CSA compound in April 1985.

[158] Unlike the case with the CSA, almost all of the Order members (except those who turned state's evidence) are still venerated by the extreme right wing. The organization even spawned a more localized copycat version, sometimes referred to as Order II, which was far less successful, but just as violent, as its namesake (see Smith, p. 79 for details).

[159] Although the group took no known tangible steps towards procuring cyanide, the question of whether they decided to adopt this agent as a mass-casualty weapon is complicated and will be dealt with below.

Much of the innovation that the Order was responsible for consisted of the manner in which they attempted to professionalize and systematize their revolution, compared to what had previously often been inchoate, unplanned and sporadic violence from the extreme right wing. As such, the Order focused heavily on intelligence gathering and surveillance. Examples include their trial runs and recruiting of an inside man for the Brinks robbery, as well as the use of Jean Craig, the middle-age mother of Mathews' mistress, to gather detailed information on Alan Berg. The extent of the intelligence the group was able to collect was apparent when federal agents raided the house of Gary Yarbrough, one of the founding members of the Order, in October 1984 and discovered substantial information on local law enforcement officers, including photographs, printouts of their names and addresses, license numbers and other information, with the SWAT team leader at the very top of the list.[160] Other attempts at professionalism were the use of code names for all members (with some members never knowing the true names of others)[161] and the cultivation of assumed identities that would withstand some degree of scrutiny.[162] The Order also engaged in various counterfeiting schemes to support their revolution, beginning with rather amateurish attempts led by David Lane using equipment at the Aryan Nations compound, but later improving their quality using the Order's own press under the supervision of Robert Merki, a seasoned – albeit less than completely successful – counterfeiter.[163]

The Order was also quite innovative (for the time) with respect to the technological aspects of clandestinity, delving into electronic countersurveillance, secure communications and even embracing the nascent information revolution. With the proceeds of their armed robberies, Order members procured an array of radio scanners,

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[160] Flynn and Gerhardt, p. 318.

[161] These code names included: 'Carlos' for Robert Mathews, 'Mr. Black' for Richard Scutari, 'Brigham' for Bruce Pierce and 'Luke' for Randy Duey. For a more complete list, see Flynn and Gerhardt, p. 220.

[162] Based on the guidance provided by underground publications, Order members identified dead infants in graveyards and obtained birth certificates and other documentation like drivers licenses using these names. (*United States of America v. Ronald A. King et. al.* (CR-85-0102), U.S. District Court, Northern District of California, Tuesday, 12 Feb. 1985; Flynn and Gerhardt, p. 139). Later on, their chief counterfeiter, Robert Merki, also produced phony identification documents for group members, including Costa Rican driver's licenses and ostensibly even working on a fake ID for the National Security Agency (Flynn and Gerhardt, p. 295).

[163] Singular, p. 205; Flynn and Gerhardt, p. 140. The initial attempts at counterfeiting produced easily detectable $50 bills, whereas later efforts produced $10 bills that were generally passable. However, it was the injudicious use of these $10 bills that resulted in the apprehension of Thomas Martinez, an Order operative in Philadelphia, and which eventually led to the FBI infiltrating the group through Martinez.

transceivers, night-vision equipment, scrambled walkie-talkies, a seismic intrusion detector, radio frequency detectors (to discover wiretaps), voice stress analysers and telephone scramblers.[164] It was suspected that much of this electronic equipment was obtained from Tom Metzger, a leading figure in the Ku Klux Klan, who operated an electronics business in the San Diego area.[165] Mathews also set up a sophisticated communications network with manned phone drops[166] and contingency numbers if members got arrested (called the 'Beartrap'[167]), and the Order purchased several computers for accessing Louis Beam's (of Aryan Nations) new electronic bulletin board (a progenitor of today's websites). The latter, known as the Liberty Net, was set up to disseminate right-wing propaganda, tactics and hit lists.[168] David Lane, a senior Order member, even inquired into how to disable telephone networks in major metropolitan areas, with the notion of circumventing alarm systems during robberies, although this was never attempted.[169]

With respect to weapons in particular, the Order accumulated an immense arsenal of small arms. Court records of items seized from Order members list hundreds of weapons, including fully automatic assault rifles, some of them customized, and enormous quantities of ammunition.[170] The Order was also not shy about acquiring explosives, purchasing or otherwise acquiring several pounds of C-4 plastic explosive, dynamite, dozens of grenades, detonators, black powder, and Kinestik™ (a brand of binary explosive).[171] Several Order members, including Gary Yarbrough and Dan Bauer, also had explosives expertise and built bombs using the acquired explosives, often for the purpose of providing a diversion for police in order to facilitate their

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[164] Detailed lists of such items can be found in the confiscated equipment lists presented in Second superseding indictment at 17, *USA v Pierce et. al.* (CR85-001M) and Flynn and Gerhardt, pp. 254, 333.
[165] Government's Memorandum on Sentencing, *United States of America v. Frank Silva* (CR85-001M), U.S. District Court, Western District of Washington, Seattle Division, p. 4.
[166] These were manned by Order members, including, at different times, Jean Craig and Frank Silva, who would receive messages from other members and distribute information (Government's Memorandum on Sentencing, *USA v. Silva* (CR85-001M); Exhibit H-2 in *USA v. Lane, et. al.* (87-CR-114); Flynn and Gerhardt, p. 295).
[167] Flynn and Gerhardt, pp. 296, 308.
[168] Singular, p. 234.
[169] Flynn and Gerhardt, pp. 106-107.
[170] For illustrative lists, see: United States Attorney, Western District of Washington, *News Release* (15 Apr. 1985), p.7; Second superseding indictment at 17, *USA v Pierce et. al.* (CR85-001M).
[171] Indictment at 35, *United States of America v. Robert Edward Miles, et. al.* (CR87-20008), United States District Court, Western District of Arkansas, Fort Smith Division; United States Attorney, Western District of Washington, *News Release*, p. 7; Second superseding indictment at 17, *USA v Pierce et. al.* (CR85-001M); Singular, p. 211.

robberies.[172] One innovative bomb attack that was conceived of but never implemented was a suicide bombing of Baron de Rothschild in November 1983.[173] Yet, in terms of the weapons themselves, there was little that stood out from the arms acquired by many other right-wing extremists at the time.

In contrast to the relatively prosaic weapons actually used by the Order, there was one example of the Order pursuing an exotic weapon. In the wake of the windfall from the Ukiah armoured car robbery, one of the more peripheral Order members, Daniel Bauer, proposed to the core members that they fund certain right-wing scientists to work on microwave and laser-beam weapons to help fight ZOG. Bauer had ostensibly been contacted by sympathetic scientists in the eastern Washington area who had been working in these fields. He suggested that the Order fund their research, under a project which received the moniker of 'Reliance', including setting up a front business and helping the scientists to relocate and obtain new identities as part of this project. Although senior Order operator Bruce Pierce vociferously objected to such plans as a waste of money, the remainder of the inner circle including Mathews went along with Bauer's suggestion and, according to Singular, provided $100,000 for the project. Needless to say, the proffered project was a scam concocted by a rather creative writer acquaintance of Bauer and the money was never seen again.[174] One other purported enterprise of the Order that has scant evidence, but is nonetheless worth a brief mention, is what has been described as the Order's attempts to create an 'Aryan air force'. In March 1984, Mathews may have tried to obtain an unspecified aerial capability by recruiting two pilots and their planes, none of which were apparently very airworthy.[175] Bruce Pierce also became very interested in flying and purchased an ultralight aircraft.[176]

Cyanide

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[172] For example, a fake bomb was utilized on 30 January 1984 to divert police from a bank robbery and in Spokane a real bomb was detonated inside an adult film theatre on 22 April 1984, the day prior to an armed robbery, in order to give credence to a diversionary bomb threat during an armoured car heist the following day (Flynn and Gerhardt, pp. 130, 150).
[173] Flynn and Gerhardt, p. 106.
[174] Singular, p.239; Flynn and Gerhardt, p. 299; Coates, p. 73.
[175] See Singular, p. 205. Although never explicitly linked to the Order, the two pilots may have been the McCoy brothers, two hapless right-wing extremists reported in Bill Morlin, 'FAA Brings Action Against Two-Plane "Aryan Air Force"', *Spokane Chronicle* (4 March 1985), p. 3.
[176] Second superseding indictment at 17, *USA v Pierce et. al.* (CR85-001M).

The situation with respect to cyanide is somewhat complicated. Shortly before Mathew's fatal showdown with federal authorities on Whidbey Island in December 1984, Bruce Pierce, who had taken on the role of key mission planner for the Order, reported back to Mathews on his recent activities and was discussing cutting electricity supplies to Los Angeles. Once he had achieved this, Pierce contended that his team would 'drop a tub of cyanide into the aqueduct. Hell, it'll probably be detected at the filtration plants, but either way, we're causin' problems. The niggers'll be in the streets in an hour, and the cops'll be shooting. I just hope the big quake doesn't get 'em before we do'.[177] This was the only mention of cyanide and there is no further evidence that Pierce either pursued or possessed any actual chemicals, especially since he had to go on the run from authorities shortly thereafter, ultimately being arrested in March 1985.

There does, therefore, seem to have been some interest in cyanide, which could conceivably be construed as a decision to adopt it as a weapon. On the one hand, it might be argued that, given the time and space in which to operate, Pierce would have pursued the acquisition of the toxic chemical and that it was only the intensive nationwide manhunt for him that precluded this. On the other hand, this might have merely been the somewhat fanciful musings of a subordinate eager to please his beleaguered superior (Mathews) with daring tales of large-scale attacks to come. After all, at this point in time, the Order members knew that the authorities were breathing down their necks, so to speak, and Mathews had just written a Declaration of War and hinted to his comrades that he would probably not be much longer for this world.[178] The latter interpretation is made more likely considering the context of the prior relationship between these two strong personalities, which had involved Pierce openly challenging Mathews for more autonomy, but still wanting to have Mathews as a leader, and presumably seeking to justify the independence and resources that Mathews had given him specifically to plan and engage in operations.[179] At the same time, Pierce seems to realize (unlike the CSA) that cyanide would be more disruptive than destructive and thus more of a facilitator of public instability than a mass-casualty weapon. The most that can be said for analytical purposes from the available evidence, therefore, is that there was a partial or equivocal decision to adopt cyanide, which may or may not have been serious but in either event was not followed up in any way whatsoever.

[177] Flynn and Gerhardt, p. 359.
[178] Flynn and Gerhardt, p. 354.
[179] Flynn and Gerhardt, p. 281.

Rockets

There is no real evidence of the Order ever seriously pursuing or acquiring rockets. In fact, the closest that the group ever came to a rocket appeared to be the two M158 Ground Red Star Clusters, which are essentially signalling flares, that were among the materials confiscated from Gary Yarbrough.[180] They did appear to comprehend the possible utility of rockets, however. In preparation for the Ukiah robbery, Mathews acquired a length of cardboard tubing which was to be disguised as a bazooka in order to intimidate the armoured truck guards. Flynn and Gerhardt assert that Mathews had originally sought a military light anti-tank tube for this purpose but had been unsuccessful. They specifically refer to Mathews' desire to acquire the firing tube, rather than the rocket itself. Light anti-tank weapons (LAWs) are usually one-shot rockets with tubes that are discarded after a single use and are far easier to acquire than the LAW itself, which implies that Mathews was after the tube merely as a prop without any intention to acquire an actual weapon.[181]

For parsimony in analysis, the activity of the Order can be separated into two main phases, as follows:

1. *Building the Brotherhood* (September 1983 to 16 July 1984): This phase begins with the oath-taking that created the Order and traces the gradual increase in confidence and consequence of the Order's actions, up to the colossal robbery of the Brinks truck in Ukiah, California.
2. *Burning Brightly and Briefly* (16 July 1984 to 8 December 1984): The second phase begins with the organization's devolution to a cellular structure and expanding influence in the far right, while authorities simultaneously drew closer and closer to apprehending them, culminating in Mathews' fiery death.[182]

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[180] Ibid.
[181] Flynn and Gerhardt, p.229.
[182] Although some members of the Order remained free for several months thereafter, they were being hotly pursued by federal officials the entire time and did not carry out any terrorist activities during this period.

Innovation Awareness

Cyanide

At least some members of the Order were clearly aware of the potential for cyanide to be used as a pollutant, as is made obvious by Bruce Pierce's statement above. The question then becomes how this awareness arose. There are several possible channels, all of which are based on the group's extensive connections with the various elements of the American far right.

Mathews had been an itinerant attendee at many of the key far right centres for several years prior to his founding of the Order, getting to know the various ideologues as his personal belief system was being moulded. One of the places that he had visited several times was the Aryan Nations compound of Richard Butler in Hayden Lakes, Idaho. Flynn and Gerhardt assert that Mathews was not overly captivated by Butler, but rather enjoyed the comradeship to be found among fellow white supremacists there,[183] from whom he later recruited at least four members of his guerrilla army. Nonetheless, he (along with all nine of the founding members of the Order) was present during the July 1983 Aryan Nations Congress at which the far right became exercised over the death of Gordon Kahl.[184] Besides being the turning point at which Mathews decided for once and for all that more vigorous action was needed than just the endless remonstrations by the movement's old guard, this was also the setting of clandestine meetings between the far right's leaders during which they plotted their strategy for the overthrow of ZOG.[185] As part of the meetings, which were attended by among others James Ellison of the CSA, the pollution of water supplies was explicitly put forward.[186] A 1987 sedition indictment of right-wing leaders alleges that Mathews (who was already regarded in the movement as a promising young firebrand) was included in these meetings,[187] but even if he was not, it is likely that word got out to other attendees about the content of the meetings,

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[183] Flynn and Gerhardt, p. 84.
[184] Indictment at 6, *USA v. Miles et. al.* (CR87-20008).
[185] Smith, *Terrorism in America*, p. 61; See also the related discussion in the CSA case study.
[186] Indictment at 8, *USA v. Miles* et. al. (CR87-20008).
[187] Indictment at 7, *USA v. Miles et. al.* (CR87-20008).

and one or more of the future members of the Order heard about the plans to poison water supplies.[188]

A second potential source of the Order's knowledge of cyanide's potential as a mass-casualty weapon was its close contacts with the CSA. As already mentioned in the profile of that organization, several Order members fled to the CSA as fugitives.[189] Yet the connections between the two groups predate Order members' search for a refuge and go deeper than the mere fact that they moved in the same far right circles, of which the July 1983 Aryan Nations Congress was but one example. Rather, the Order recruited several former members of the CSA, who were already linked to one another in a sort of alumni network. These included at least three individuals who would play key roles in the Order: Randall Rader, who had taken on the chief paramilitary role in the CSA before falling out with James Ellison (Rader was recruited to supervise the Order's training activities); Andrew Barnhill, a smart young former CSA member who was reportedly adept at mathematics;[190] and Richard Scutari,[191] who became the Order's chief of security and Robert Mathews' confidant. Robert Merki, a former industrial engineer, who with his wife Sharon would play a large role in the logistical operations of the Order, had also reportedly managed a gold mine in Costa Rica on behalf of the CSA.[192] It is probable that at least one of these individuals (most likely Rader) knew of the cyanide stored at the CSA and what it was to be used for and was thus a conduit for information about the possibilities of cyanide use to the Order.

Rockets

Although there is no mention of rockets associated with the Order, it is almost certain that its members were aware of the weapons and their possibilities for standoff attack. The strongest argument for this lies with the *Turner Diaries*, which – as has been previously described – is rife with references to mortars and other rocket-like

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[188] The available court documents do not state whether a specific toxic agent was mentioned, but cyanide would be a prime candidate, given that most laypeople are aware of its toxic reputation.
[189] At least four Order members were present at the CSA in early 1985 and it is highly probable that David Tate and Frank Silva were making their way to the CSA when they were arrested.
[190] Flynn and Gerhardt, p.139.
[191] Scutari had been involved with the CSA in 1982 (Henrik Holappa, 'The Years with Richard Scutari' in Söderman and Holappa, p. 12; Hamm (2007), p. 125).
[192] Coates, p. 68.

projectiles. Many books influenced Robert Mathews on his road to violence,[193] but none more so than the *Turner Diaries*. Mathews reportedly memorized every word of the novel, and drew on it as the blueprint for much of his activity. He would certainly, then, have been aware of the positive light in which the novel paints these weapons. In addition to this fictional referent, several members of the Order had actually served in the military, including Denver Parmenter, Randy Duey, Gary Lee Yarbrough, James Dye[194] and Richard Scutari,[195] while Randall Rader had built up an extensive knowledge of military matters. All of these individuals would have encountered rockets – if not in practice, at least in theory – at some time during their military training and service and would thus have been aware of their potential for use as a weapon in the Order's attacks. Last, Mathews had been inspired by Robert Bolivar DePugh and his violent Minutemen group of the 1960s and would have most likely been aware of their acquisition of rockets in anticipation of attacks on targets in the Northeast. [196]

The Adoption Decision

People and Process

Turning first to the decision making process, the main driver behind almost all Order decisions – including whether or not to adopt new weapons – was its founder Robert Mathews. Understanding something of Mathews' character and development can thus lead to insights into the Order's weapon selection decisions. Mathews had followed an incremental path towards violent extremism, starting with the John Birch Society and the tax protest movement and working his way through to neo-Nazi groups like the National Alliance and Christian Identity groups like Aryan Nations, along the way becoming increasingly alienated from his family.[197] Also, from a relatively early age, Mathews demonstrated the capacity to exercise charismatic authority – at only nineteen

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[193] These included *Which Way Western Man?* by William Gayley Simpson and *Essays of a Klansman* by Louis Beam (Flynn and Gerhardt, pp. 81, 93-94).
[194] Walt Wiley and Herb Michelson, 'Pieces Missing in Order Puzzle', *Sacramento Bee* (8 Apr.1985); Flynn and Gerhardt, p. 159.
[195] Scutari was a former U.S. Navy diver and member of its elite Underwater Demolition Team, as well as being a martial arts expert (Olivier Devalez, 'A True Friend of Mine', in Söderman and Holappa, p. 63; Interview with Richard Scutari, posted on *Stormfront.org*, http://www.stormfront.org/forum/t276328/. Accessed 9 July 2012).
[196] Flynn and Gerhardt, p. 22.
[197] Ashley Dunn, 'Mathews had a History of Rightwing Fanaticism', *Seattle Post-Intelligencer* (10 Dec.1984), p. A-8.

years old in Arizona, he pulled together a short-lived army of would-be anti-government guerrillas called the Sons of Liberty. This early experience served him well when, after a failed attempt to peacefully establish a 'White American Bastion' as a white sanctuary in the Pacific Northwest,[198] he set about creating the Order. Mathews exhibited intelligence, was well read in far-right politics and possessed impressive rhetorical skills, as can be seen in the impassioned and eloquent, if extremely violent, imagery in the following extract from the oath which he instituted for initiation into the Order:

> My brothers, let us be his battle ax and weapons of war. Let us go forth by ones and by twos, by scores and by legions, and as true Aryan men with pure hearts and strong minds face the enemies of our faith and our race with courage and determination. We hereby invoke the blood covenant and declare that we are in a full state of war and will not lay down our weapons until we have driven the enemy into the sea and reclaimed the land which was promised to our fathers of old, and through our blood and His will, becomes the land of our children to be.[199]

An integral component of charismatic authority is the devotion of one's followers and Mathews inspired profound loyalty in his associates. He is described as being charming, extremely generous,[200] protective of his ersatz kinsmen[201] and took several members under his wing in a mentorship role. Richard Kemp, the hammer-wielding murderer of fellow member Walter West, has said that Mathews was 'like the older brother I never had'.[202] Mathews also led from the front – engaging in behaviour that put him personally at risk and not demanding that any other member do for the cause what he was not prepared to do himself.[203] It has even been asserted that most of the members of the Order could never have anticipated their involvement in its violent activities before meeting Mathews.[204]

He was, however, not above blatant manipulation to get what he wanted, for instance promising several of his associates who were hesitant regarding assassinations that he

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[198] Flynn and Gerhardt, p. 9.
[199] Flynn and Gerhardt, pp. 98-100.
[200] Flynn and Gerhardt, p. 93.
[201] This was often to the point of jeopardizing the group's security, for example, when Mathews wrote a letter to a local newspaper defending Bruce Pierce (who was sought for jumping bail in the wake of an arrest for counterfeiting) and vowing to stand together with him in the struggle (Hamm (2007), p. 132).
[202] *Turning Point: The Order*.
[203] Richard Scutari lauds Mathews because 'On every operation he insisted on taking the most dangerous position. He was a man who led by example, something our movement is greatly lacking today' (Söderman, 'Interview with Richard Scutari', p. 116). Furthermore, Mathews quit his employment in order to show his commitment to his plan and suffer the same hardship as his unemployed brethren in the Order (Flynn and Gerhardt, p. 109).
[204] *Turning Point: The Order*.

would not go ahead with these activities, while actively pursuing them with the more enthusiastic members.[205] 'He knew what buttons he could push on me', recalls a former member.[206]

Mathews also had a visionary bent, believing that the transition to a better world (for the White race) could be initiated by the direct action of his group and others like it, even if they themselves did not achieve their ultimate objectives. This outlook was evident from one of his oft-used phrases to his men: 'Cattle die, kinsmen die, and I too shall die. The only thing I know that does not die is the fame of dead men's deeds'.[207] This partly explains the elaborate rituals and grandiose oaths he created for entry into the organization or the quixotic Declaration of War he wrote and had Order members sign shortly before his death – he was preparing a legacy for himself and a path for others to follow. This complete commitment to a sought-after White future also allowed him to maintain his resolve in the face of setbacks. For example, in March 1984, when the group was low on money and seemed in danger of dissolving, he pawned his wedding ring to purchase the equipment needed until they managed to secure sufficient funds to continue by robbing an armoured truck outside a Fred Meyer store.[208]

Less helpful were Mathews' argumentativeness and his tendency to accelerate the group's activity beyond what was strategically prudent. As a former friend characterized him, 'He wouldn't slow down…Bob had to keep going …go go go go go'.[209] The result was increasingly rash outbursts, reckless decisions and outlandish plans, such as his ideas (during the October to November 1984 timeframe) to launch an armed assault to rescue Frank Silva and Robert Merki from a pub where the FBI had them cornered or to raid law enforcement offices to recover property confiscated by federal agents from Gary Yarbrough.[210] This behaviour – together with Mathews' inherent fatalism – led, in the weeks before Mathews' death, to a number of members seeking to leave the group

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[205] Flynn and Gerhardt, pp. 192, 217. When confronted after the Berg assassination by Rader about this deception, Mathews 'listened quietly for a moment, then shrugged and walked away' (Singular, p. 228).
[206] *Turning Point: The Order*. The speaker remains anonymous in the documentary, but through cross-referencing other statements and contextual information, he is almost certainly a member by the name of Ken Loff.
[207] Flynn and Gerhardt, p. 185. It can also be inferred from Mathews' use of some of the proceeds from his robberies to support a sperm bank with the express purpose of siring future Aryan warriors (Hamm (2007), p. 140).
[208] Flynn and Gerhardt, pp. 132, 134, 137.
[209] *Turning Point: The Order*.
[210] Singular, p. 246; Flynn and Gerhardt, pp. 322, 324.

and may have been one reason why Mathews stubbornly refused to surrender to authorities on Whidbey Island.

Mathews may have been the linchpin of the Order, but he was not a dictator. Tensions had been simmering between Mathews and Bruce Pierce in particular, ever since Pierce had been arrested for counterfeiting in early 1984 and had indiscreetly called Order members from jail. This friction grew over the ensuing months and came to a head right after the successful Ukiah robbery in July.[211] Pierce, backed up by several other core members, confronted Mathews and demanded a greater say in the Order's affairs and more autonomy. Mathews – somewhat surprisingly to some witnesses – backed down and essentially agreed to their demands. This led to a transition over the next few months to a new, more cellular organizational structure in which Pierce managed his own operational group with a substantial portion of the loot, and various other members were assigned to take control of specific tasks such as recruitment, training, security and so forth.[212] Mathews continued to oversee the broader strategy and growth of the group, but the change meant that after this point, tactical decision-making, presumably including weapon selection, was more dispersed between Mathews and Pierce. After Mathews' death, Pierce – who was, if anything, even more action-oriented than Mathews – assumed the role of *de facto* leader.

Influencing Factors

Cyanide and Rockets

It is now possible to explore why the Order did not choose to pursue rockets or cyanide (or in the case of cyanide, at least not until the end and even then only abstractly). After all, there were several elements that the group had in common with the CSA, which did pursue these weapons. First, like the CSA, the Order did not really have any moral compunction against causing mass casualties. Ideologically, the Order wholeheartedly embraced many of the core Christian Identity beliefs, including the primacy of the White race, the inherent wickedness of the Jews, and a global conspiracy – manifested

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[211] For details of the individual episodes leading to this growing tension, see Flynn and Gerhardt, pp. 132,154, 200.
[212] Transcripts, Friday, 4 Oct. 1985 at 3138, *USA v Pierce et. al.* (CR85-001M); Singular, pp. 238-9.

in America as ZOG – to dilute and dissolve the Aryan race. In fact, many of the Order's central members were dedicated Identity adherents drawn from places like Aryan Nations or the CSA. Interestingly though, Mathews himself was an Odinist,[213] and thus much of his writing lacks the biblically-derived, overtly apocalyptic references common among Identity groups, while its anti-government features were even more pronounced. Mathews also appears to have been rather more focused on the concept of sacred ancestral land than some Identity preachers. He was, however, not above utilizing explicit Christian references for instrumental purposes in order to maintain the loyalty of his followers and to broaden his constituency,[214] as when he ended his declaration of war with 'Therefore, for Blood, Soil, and Honor, … and for our King, Jesus Christ, we commit ourselves to Battle'.[215] Whatever his personal theology, it dovetailed with Christian Identity in legitimizing large-scale violence against Jews, non-Whites and perhaps even to some extent the unenlightened white public, whom Mathews often referred to as 'sheeple', as part of a holy cause.[216] As testament to the acceptability of inflicting mass casualties, a poem by Mathews that was recovered during the federal investigation of the Order includes the verses: 'Reclaim our sacred ground for Aryan men and Aryan women.//Let the seas run red with the blood of the fleeing alien hordes'.[217]

Nor were Mathews or the other members of the Order Luddites who spurned new technology. In some ways they were even more explicit about the need to utilize technology than the CSA and James Ellison were. In addition to the evidence for this set forward by their fondness for electronic equipment, their faith in voice stress analysis as a means of detecting deception[218] and Mathews' enthusiasm for the high-tech Reliance Project, it has been argued that members felt that they needed to acquire technology in order to be on an equal footing with their enemy, because 'ZOG's got it and we

[213] Singular, p. 127. Coates (p. 67) describes how, just before the Berg assassination, Jean Craig, who was a devoted acolyte of Mathews', had thrown Nordic rune stones to establish the auspiciousness of the attack.
[214] In this regard, he was probably thinking along the lines of Richard Scutari, who subsequently converted to Odinism (or its modern racist variant, Wotanism), and has remarked that 'Christian Identity is a stepping stone to bring some of our people back to thinking racially. Its message reaches a portion of our People who otherwise could not be reached. As such, it is a tool that still needs to be used' (Söderman, 'Interview with Richard Scutari', p. 108).
[215] Flynn and Gerhardt, p. 357.
[216] Flynn and Gerhardt, p.86.
[217] Robert Mathews, [Untitled Poem], *White American Resistance*, 4:2 (1985), p. 5, journal presented as an exhibit in *USA v. Pierce et. al.* (CR85-001M).
[218] Interview with Richard Scutari, posted on *Stormfront.org.*

don't'.[219] What is more, as we have seen, several members of the Order had prior military, paramilitary or engineering training, including the ability to build working time bombs and Randall Rader's previous experience with converting firearms to automatic fire. It is unlikely, therefore, that they would have refrained from at least attempting to acquire either rockets or cyanide based solely on a lack of confidence in their technical abilities.

Why then, given all these apparently favourable factors, did the Order not seriously attempt to innovate with respect to weapons, at least not until the very end of their lifespan?[220] Obviously, the brief duration of their operational activity played a part – it was only a little over fifteen months from the creation of the Order until its demise as a coherent organization. However, the relatively short window in which to consider weapons adoptions cannot be the entire explanation; the organization was extremely dynamic, making multiple important strategic and tactical decisions during this period and there is no reason why adopting a new weapon could not have been one of them, irrespective of how far they proceeded towards actually doing so. For similar reasons, neither can the sole reason be attributed to Mathews' and the others' proclivity for action – while engaging in their struggle at an almost breakneck pace during 1984, they still invested time and resources in such preparatory activities as gathering intelligence on potential targets and recruiting new members, and thus could arguably have devoted some attention to weapons procurement or production while engaging in their other undertakings. Rather, it is argued that the primary factor responsible for a lack of attention to weapons innovations was that such activity was incompatible with Robert Mathews' strategy at the time.

To demonstrate this, it is necessary to appraise the link between the Order's strategy and the *Turner Diaries*. Far from merely being an abstract inspiration for Mathews and providing the name its members sometimes used for the organization, the *Turner Diaries* served as the direct blueprint for the Order's revolution. The close connection between the two is so blatant that it has been remarked upon, not only by every scholar who has studied the organization, but even by the prosecutor at the main trial of the Order members, all of whom draw parallels between the early chapters of the *Turner*

[219] Flynn and Gerhardt, p. 128.
[220] As will be argued below, the Reliance project, despite the large amount of money involved, should not be viewed as a focused weapons adoption attempt by the group.

Diaries, which include counterfeiting, robberies of armoured cars and banks, assassinations and bomb attacks, and many of the other criminal acts engaged in by the Order (see Table 7.2 for details).[221] Mathews, besides knowing the text inside and out, is reported to have given each member of the Order a copy of the book to study. Yet it is argued that Mathews' exploitation of the *Turner Diaries* goes far beyond mere emulation of its tactical repertoire. Mathews and his cohort actually adopted the *strategy* implicit in the *Turner Diaries*, which is, at its heart, little more than an updated version of the works of Mao and Marighella taken to extremes and adapted to the contemporary American context.

Mathews essentially took the *Turner Diaries* and married its strategic precepts with his (and the novel's) aim of establishing a separate white nation on American soil. He did this by distilling his understanding of the strategic narrative of the novel into six steps, which he laid out at the time the Order was formed, as follows:

1. Form the group.
2. Set goals – what the group wants to achieve and how far it is willing to go to achieve them.
3. Establish a war chest, i.e., procure funds.
4. Recruitment and distributing funds to right-wing causes.
5. Assassination of racial enemies (Jews or Gentile traitors).[222]
6. Formation of a guerrilla army with the ability to carry out sabotage in urban areas.[223]

From the above list, one can see that weapons capable of causing mass casualties or requiring standoff capabilities would most likely only be truly needed when step six is reached. Before then, small arms and standard explosives would in almost all cases suffice. Mathews followed these six steps faithfully and since the Order never really moved on to step six, expending resources on new weapons before then would detract from the achievement of its current goals.

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[221] For various expressions of this idea, see Dees and Corcoran, p. 144; Hamm (2007), p. 116; Coates, p. 50 (also for the prosecution statement); Singular, p. 66; *Turning Point: The Order*; Smith, p. 67; Barkun (1989), pp. 416-417.

[222] While outlining step five, Mathews established a 'doomsday plan' in which, if the group was facing extinction from authorities, each member was assigned a high-profile target to attempt to kill at all costs. Targets included Henry Kissinger and then Chase Manhattan Bank president David Rockefeller (Singular, p. 135).

[223] These points are laid out in the affidavit of FBI Special Agent Patrick J. Webb in *United States of America v. Charles E. Ostrout* (CR85-102-2), U.S. District Court, Northern District of California, and Flynn and Gerhardt (pp. 97-98), which differ slightly with respect to steps two and three. Where they differ, I have adopted those of Flynn and Gerhardt, which represent a more logical progression.

An example that shows Mathews' reticence to deviate from this strategic prescription is to be found in November 1983. During surveillance of targets to rob in Seattle (in furtherance of step 3), the group discovered that one of the far-right's most avowed enemies, the Baron de Rothschild (who, according to right-wing literature is one of the leaders of the Satanic Jewish cabal seeking to control the earth), was to be visiting the city shortly. Many of the members in the group took this as a sign, or at least an opportunity that was too good to pass up, and pushed for a plan to assassinate Rothschild at the Four Seasons Hotel. Mathews strenuously resisted this, arguing that it was not yet time for step five and that they first had to acquire a war chest. This caused much disagreement, resulting in the group leaving Seattle without even implementing their robbery plans.[224] Mathews' willingness to forego a tempting opportunity and to do so even at the expense of discord within his embryonic organization demonstrates his commitment to his strategic principles. A further example can be found in the wake of the Ukiah robbery in July 1984, when the Order was flush with millions of dollars of cash. True to his word, Mathews duly implemented step four on a large scale.[225] Akin to a racist Robin Hood, he dispatched Andrew Barnhill and Denver Parmenter as 'Order missionaries' across the country, reportedly distributing roughly $650,000 to various far right leaders, including William Pierce, Richard Butler, Tom Metzger, Robert Miles, Louis Beam and Glenn Miller.[226]

It remains to explain Mathews' support for the Reliance project in July 1984, since this is seemingly inconsistent with the hypothesis that Mathews eschewed weapons development and adoption at this stage of his strategic design. For several reasons, the Reliance project can be viewed as the proverbial exception that proves the rule. First, this was a serendipitous opportunity that was not sought out by Mathews and therefore his acquiescence to Bauer's request cannot be regarded as part of his broader strategic intentions. More importantly, the Reliance project was relatively costless to the organization and would not detract from its core plan. The project did not demand any time or manpower resources from the group, since it was to be ostensibly carried out by

[224] Hamm (2007), p. 128; Flynn and Gerhardt, p.106.
[225] He had already begun implementing step four previously, setting aside a portion of the proceeds of the prior robberies for right-wing causes and continuing to recruit. The assassination of Alan Berg, i.e., the initiation of step five in June 1984, is thus not inconsistent with his strategy. The post-Ukiah distribution of funds and recruitment is noted here, however, because it entailed a significant investment of Order resources that could have been devoted to other activities like engaging in larger-scale attacks.
[226] Dees and Corcoran, p. 45.

non-group scientists. All it required was the investment of money and, in the immediate aftermath of the Ukiah robbery, the Order had ample funds available. So, whereas only a few months earlier, $100,000 would have seemed a gargantuan sum, at the time it represented less than 3% of their recent haul. Investing in the Reliance project therefore had an extremely low opportunity cost for the organization and presented the Order with a unique value proposition in that it could potentially provide a 'silver bullet' against the government. No such outside benefactors were present to assist with the acquisition of other weapons like rockets or cyanide.

Indeed, the strategic incompatibility hypothesis is supported even if one considers cyanide to have been selected for adoption in late November or early December 1984. For, although in the last few months of 1984 the Order was under tremendous pressure from authorities and essentially on the run, it can be argued that Mathews and the others felt that the time had finally come to move on to step six.[227] One aspect of this is Mathews' reported statement, during discussions relating to his declaration of war, that, 'It's time to introduce ourselves and get the word out that we exist'.[228] In this light, with step six finally being embraced, the Order could look towards more expansive attacks and more damaging weapons. It is thus no surprise that at that stage a variety of attack plans were bandied about to initiate the Second American Revolution, from attacks on the Los Angeles Olympics and aspirations to cut off the city's electricity, to consideration of dumping cyanide in water supplies.[229]

Reason for Adoption Success (or Otherwise)

Even if one does concede that the Order intended to adopt cyanide as a mass-casualty weapon, they clearly had no opportunity to do so, most obviously because the group did not endure long enough to implement any of its more grandiose plans. Following his arrest for counterfeiting in Philadelphia, member Thomas Martinez had been cooperating with the FBI since at least the beginning of October 1984 and disclosing all

[227] Flynn and Gerhardt contend that by the end of September 1984, with various cells fulfilling their designated functions, and new plans underway for gruesomely assassinating Morris Dees of the Southern Poverty Law Centre, Mathews felt that he could begin planning significant terrorist attacks (Flynn and Gerhardt, pp. 295-296).
[228] Flynn and Gerhardt, p. 354.
[229] *Turning Point: The Order*.

of the Order's secrets.[230] So, just as Mathews began to see the time as ripe for implementing the guerrilla warfare elements of his plan in step six, the Order was infiltrated and its members had to flee to escape authorities.

While space restrictions preclude exploring the counterfactual in depth here, there are certain reasons to suspect that even if Martinez had not betrayed the group (which might be regarded as a 'lucky break' for authorities), Mathews and the Order would by no means have been certain to succeed in adopting cyanide. Even though the group was tactically creative, committed to its cause and ambitious when it came to operational security (with phone drops and codenames), its tradecraft, or rather the members' practice thereof, left a lot to be desired. Members made very basic errors, such as Mathews leaving a gun behind at the scene of the Ukiah robbery, one which Andrew Barnhill had purchased in his own name.[231] Members also held on to incriminating evidence as souvenirs of their exploits, or what Mark Hamm has referred to as 'totem'.[232] For example, the gun that was used to murder Alan Berg was found, together with a trove of damning documentary evidence, at Gary Yarbrough's house when it was raided.[233] Richard Scutari, who after joining in June 1984 tried to enhance security practices, often rebuked Mathews for not compartmentalizing information and 'letting everyone know everything'.[234] Some members even exhibited delusional thinking, as when Randall Rader began believing that a coven of witches was spying on the training camp that he had set up for the Order.

Moreover, while members had military and some degree of technical expertise, the Order did not possess anyone with knowledge of chemistry or how chemical weapons function. At least Pierce recognized this to some extent when he acknowledged that the cyanide would be more likely to disrupt than kill, though with the dilution and treatment factors associated with water supplies of major urban areas, even this would have been a tall order. Possibly the most damning factor for the group's chances of success is the argument that the group's dependence on a single individual, Robert Mathews, for its

[230] Flynn and Gerhardt, p. 335.
[231] The Order did exhibit qualities of a learning organization in incorporating the lessons of past mistakes, such as when Bruce Pierce decreed that the men in his cell would use lanyards to connect to their weapons, so that they would not lose them on operations as Mathews had done (Flynn and Gerhardt, p. 282).
[232] Hamm (2007), p. 142.
[233] Flynn and Gerhardt, p. 318.
[234] *Richard Scutari to Magnus Söderman* (6 Apr. 2008) in Söderman and Holappa, p. 32.

cohesion made it inherently unstable, as can be seen from its rapid dissolution after Mathews' death in which members turned on each other in the face of security pressures.[235]

[235] Smith, p. 73.

Chapter 8: Cross-Case Comparison and Model Analysis

Having probed deeply into four individual cases in the previous chapters, the discussion can now turn to analysing these cases in terms of their relationship to one another and to the more general phenomenon of weapons adoption. This chapter will first provide a qualitative comparison across all four cases, summarizing the similarities and differences between the members of each pair and analysing the set of cases as a whole. The Terrorist Weapons Adoption Model formulated in Chapter 4 will then be applied to each pair and compared with the qualitative results. Lastly, an analysis will be undertaken of the performance of the model overall, resulting in refinements to the model being presented at the end of the chapter.

Cross-Case Qualitative Comparison

Taking the cases pairwise initially and beginning by looking at the first case pair (the PIRA-INLA with respect to mortars), the cases reveal that, overall, the PIRA was a vastly more innovative organization that quickly built up the required *techne*, *mētis* and institutional capacity required to successfully adopt mortar technology and thereby to increase its prestige and adapt its arsenal to the changing conditions of its armed struggle. As Oppenheimer contends, '…it was in the series of homemade mortars produced by the IRA that its ingenuity was revealed, and its ability to supplement imported war-fighting equipment by developing its own'.[1] On the other hand, observers have pointed out that the INLA did not develop or even attempt to acquire mortars because it quite simply lacked the organizational capacity to do so.[2] The adoption of the mercury tilt switch indicated that there were some technical and operational 'bright lights' within the INLA, but the opportunities did not really exist within the organization for these innovators to embark on a sustained programme of weapons development.[3] The INLA's technical innovation hit a peak with the mercury tilt switch and, together with its overall fortunes, seemed to decline from there. As one interviewee succinctly observed, it was as if the INLA 'had a great first album, but couldn't follow it up with another hit'.[4]

Turning to the second case pair (CSA and the Order with respect to cyanide and rocket weapons), one sees a contrast in terms of the balance between strategic and ideological influences on adoption behaviour. The story of the CSA's weapons innovations is very much one about ideology and how it can impact the decision-making of those who subscribe deeply to it. It was an incremental metamorphosis in their ideology – from fundamentalist Christianity to survivalism and thence to Christian Identity – which led the organization to increasingly militaristic behaviour. Part and parcel of this transition to an offensive posture was a search for new targets and the weapons with which to attack them. Despite possessing at least the rudiments of an in-house research and development capability, the CSA's ambitions to deploy cyanide and rockets were stymied by a lack of the *techne* and *mētis* required for these sophisticated weapons and a limited talent pool, even when, in the case of cyanide, the group was presented with the raw materials as a gift. Yet, it was primarily the very same apocalyptic and paranoid ideology which spurred the CSA's weapons adoption in the first place – together with the cognitive distortions that these extreme beliefs brought about – that ultimately sabotaged the group's ability to deliver on their weapons ambitions. In other words, the CSA was extremely innovative with respect to weapons in spirit but had trouble following through in practice.

In contrast, the Order, although motivated by very similar ideological precepts to those espoused by the CSA, was constrained by its strict adherence to a strategic doctrine that limited the group's need to adopt new weapons. So, while the Order was a whirlwind of activity, creativity and even innovation in several respects, this did not extend to the realm of the weapons they used. It was only near the end of the group's lifespan, in the sixth stage of their strategic blueprint, that they considered the types of attacks that would require adopting weapons capable of causing large-scale murder and mayhem. However, by then it was too late – the group was imploding under the pressure of law enforcement. In addition to strategic constraints, Robert Mathews' imperative to constantly act, his and the rest of the members' poor tradecraft, and their itinerant

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[1] Oppenheimer, p. 227.
[2] Interview with McDonald: 'They didn't do mortars because they couldn't'.
[3] The inability to transform flashes of tactical and technical inspiration into the organizational momentum needed for a long-term weapons adoption highlights the difference between invention and innovation that has been pointed out in the theoretical portions of this study.
[4] Former law enforcement official 'D'.

behaviour did not create conditions amenable to the successful adoption of new weapons systems.

These dynamics will now be more closely examined across all cases. Tables 8.1, 8.2, and 8.3 below present the results for the three main dependent variables (potential weapon awareness, adoption decision and success) across all the groups, weapons and organizational phases discussed in the case studies. In each instance, a qualitative summary of the primary factors affecting the outcome is given, thus enabling a cross-case comparison. It should be remembered that each case pair represents a common context, that is, the geographic location (at the country level), time period, and broad ideology (especially the primary adversaries acted against) are similar. The columns are grouped by weapon type (even though only the second case pair dealt with the adoption of cyanide) and mortars and rockets are presented in the same column. This is done because it is unclear what type of rockets the CSA pursued, i.e., it might in fact have been mortars, but even if it were a different type of rocket, there is sufficient similarity with the PIRA case that a comparison is still worthwhile.

As seen in Table 8.1, the four cases that have been studied do not display much variance in the awareness variable – across all of the organizations and time periods, only during the first phase of the CSA was there no awareness of the weapons under consideration, in that instance because the organization in question had no interest at the time in any weapons whatsoever. Strictly speaking then, the cases do little to elucidate specifically those factors that differentiate the circumstances when an organization becomes aware of a potential weapons innovation from those when it does not. However, the cases can tell us something about the mechanisms by which organizations become aware of innovations. We see that even looking at only four cases, all three theorized awareness mechanisms, namely active searching, demonstration and proselytization, are present, which lends some provisional support to the theoretical characterizations in Chapters 2 and 3.

Table 8.1: Awareness of New Weapons

Group/ Phase	Mortar/Rocket		Cyanide	
	Outcome	Key Reasons	Outcome	Key Reasons
Positive Case 1: PIRA				
Phase I	Aware	Active searching for standoff capability to overcome counter-measures; prior demonstration; some members with military experience.		
Phase II	Aware	Same as above.		
Phase III	Aware	Same as above.		
Phase IV	Aware	Same as above		
Negative Case 1: INLA				
Phase I	Aware	Prior demonstration (incl. by OIRA and PIRA); some members with military experience.		
Phase II	Aware	Same as above.		
Positive Case 2: CSA				
Phase I	Not Aware	No interest in weapons acquisition.	Not Aware	No interest in weapons acquisition.
Phase II	Aware	Increasing militarization, incl. *Turner Diaries*, Rader's interest in military manuals and military experience of new members.	Aware	Proselytization by opinion leader.
Phase III	Aware	Same as above.	Aware	Same as above.
Negative Case 2: The Order				
Phase I	Aware	*Turner Diaries*; military experience of members; perhaps demonstration by De Pugh.	Aware	Network connections with the far right.
Phase II	Aware	Same as above.	Aware	Same as above.

Furthermore, in the case of rockets / mortars, while it was not necessarily the primary source of awareness, all four organizations were aided in becoming aware by having members with prior military experience. This suggests that, at least for weapons that are widely used in modern militaries, awareness is much more likely to occur if the organization counts among its membership current or former military personnel. A final observation in connection with the channels through which awareness flows, is the prominence of existing networks in almost all cases. Whether it was the experiences with mortars of other Irish nationalists like the OIRA and PIRA, the proselytization of cyanide by far right leaders in the United States or the prevalence of rockets in the pages of the *Turner Diaries*, most of the leaders in the groups in question appear to have become aware of the new weapons through sources within their own broader social and ideological network, rather than from sources further removed, such as television or non-movement actors. This is not to say that groups will not become aware of weapons through non-network sources such as the World Wide Web, but that in identifying possible weapons that an organization might consider adopting, particular attention should be paid to weapons that have already been adopted or advocated within their own social movement.

A noteworthy observation is that, for all the weapons considered, the organizations concerned became aware of them early on in the group's terrorist campaign (in the case of the CSA, shortly after they adopted a violent outlook), irrespective of their later adoption choices or successes. The fact that awareness was achieved so rapidly even in the 1970s and 1980s, prior to the information revolution, suggests that in today's social media and Internet saturated global polity, it is unlikely that violent non-state adversaries will remain unaware of any new, even relatively obscure, weapons for very long. Whether they will be able to infer weapons relevance in non-weapons specific technologies remains an open question.

In terms of the decision whether or not to pursue the adoption of a particular weapon, of the fourteen periods wherein a decision could have been made or continued (i.e. where an organization was aware of the possibility) there are eight decisions to adopt[5] (four of ten if one counts only the initial decision to adopt and not continuation of this decision in subsequent phases). This variation allows for some inference as to the factors underlying this decision. It appears as if a key driver of weapons adoption (as seen in the case of the PIRA with respect to mortars and the CSA with respect to rockets) is to address a perceived tactical or strategic performance gap that cannot be addressed by status quo weapons. This confirms the predictions of the theoretical discussion and mirrors the more general innovation dynamic. As to why that particular weapon was selected, the lack of any viable alternatives played a part in both these cases. This is by no means the sole driver of adoption, however, with prestige seeming to play a role in both the case of the PIRA with mortars and the CSA with most, if not all, of their weapons innovations. The strong influence of serendipitous acquisition in favour of adoption, as seen in the case of the CSA and cyanide, must also be taken into account. Albeit probably a relatively rare occurrence, if a group is presented with a new weapon, the decision calculus is inverted, because failure to actively reject the weapon becomes

[5] For the purposes of these calculations, it is assumed that the Order did decide to pursue cyanide as a mass-casualty weapon at the end of 1984. See the discussion of the uncertainties surrounding this in Chapter 7.

tacit acceptance thereof and the burden of argument presumably shifts to those members who do not desire the weapon.

Table 8.2: The Adoption Decision

Group/ Phase	Mortar/Rocket		Cyanide	
	Outcome	Key Reasons	Outcome	Key Reasons
PIRA				
Phase I	Pursued	Tactical need to overcome fortified targets with standoff capability; no viable alternatives.		
Phase II	Continued to Pursue	Need for improvements in operational effectiveness and safety; defensive co-evolution by the British; no pushback from constituencies; momentum of innovation.		
Phase III	Continued to Pursue	Same as above.		
Phase IV	Continued to Pursue	Same as above.		
INLA				
Phase I	Did NOT Pursue	Feuds and internal tensions; leadership deficiencies and turnover; no institutionalized R&D or weapons acquisition capability; resource shortages; limited talent pool.		
Phase II	Did NOT Pursue	Same as above.		
CSA				
Phase I	N/A	Not aware of adoption possibility.	N/A	Not aware of adoption possibility.
Phase II	Did NOT Pursue	No strategic or tactical need.	Pursued	Serendipitous acquisition coupled with desire for prestige among peers and ideological (and to a lesser extent strategic) compatibility.
Phase III	Pursued	Lack of alternatives to achieve tactical objectives; garner greater attention from enemies; prestige within movement; to shore up leadership of group; availability heuristic of the *Turner Diaries*; perception of feasibility due to presence of Kent Yates.	Continued to Pursue	See above.
Order				
Phase I	Did NOT Pursue	Incompatibility with strategy despite ideological compatibility and some expertise.	Did NOT Pursue	Incompatibility with strategy.
Phase II	Did NOT Pursue	Same as above.	Pursued (?)	Same as above, except may have become compatible by the end of the period.

The cases (especially the negative examples) also shed some light on why new weapons might not be adopted despite presenting certain benefits for an organization. Before its ideological shift, the CSA would never have considered using cyanide or rockets and, despite all their advantages, the Order eschewed these weapons (at least until the end of their lifespan) because they did not fit in with the leader's strategic plan. This implies that, of the many preconditions that must be present before a decision to pursue a new weapon is made, ideological and strategic compatibility between the weapon and the organization is essential. Other necessary elements are minimal organizational stability (which was lacking in the INLA's case) and a perception on the part of the leadership that the organization possesses some cadre with sufficient technical skills, or at least the ability to acquire these. Last, the cases identify a certain momentum of innovation – those organizations that did embark on innovation (the PIRA, the CSA, and in a non-weapons context, the Order) seemed to continue attempting to innovate, either with respect to the same weapon if they were successful, or in other domains, even if they failed to acquire the original intended weapon. In other words, cases where the adoption of particular weapons was pursued usually formed part of a broader pattern of organizational innovation.

Table 8.3 shows that in only a single case (of four attempts) were a group's adoption efforts an unqualified success, that of the PIRA's adoption of mortars.[6] The PIRA paints quite a high bar for success – it possessed a safe haven, a sizable talent pool with *techne* and *mētis* appropriate for the weapon it was attempting to adopt, an institutionalized R&D function, copious resources and an organizational culture of systematic learning and improvement. Few other terrorist groups have enjoyed such advantages (among those who arguably fall into a similar category are Las FARC, Hizb'allah and, before 2009, the LTTE). Yet, in order to look for guidance as to which of these attributes are necessary or sufficient for successful weapons adoption, we must turn to the cases of failure. Despite a relatively safe haven and some institutionalized R&D, the CSA failed in its attempts to adopt either cyanide or rockets. What it lacked was a sufficient talent pool with the requisite *techne* and *mētis* for the weapons it was seeking to adopt (as, apparently, did the Order). It was also hamstrung by the non-rational, ideologically-based evaluation of adoption efforts by its leadership. This instilled the adoption process

[6] Although CSA succeeded in lacing bullets with cyanide, their attempt to develop a mass-casualty weapon that could be delivered through water supplies is not considered a success.

with cognitive biases that in the case of rockets resulted in abandoning its efforts and in the case of cyanide not even realizing that additional efforts were needed.

Table 8.3 Adoption Success

Group/ Phase	Mortar/Rocket		Cyanide	
	Outcome	Key Reasons	Outcome	Key Reasons
PIRA				
Phase I	Unsuccessful	Limited resources; setting up organization.		
Phase II	Successful	Legacy capabilities reconstituted, incl. expertise and access to resources; ability to rapidly develop *mētis*; buffered and institutionalized R&D; safe havens; culture of learning.		
Phase III	Successful	Same as above.		
Phase IV	Successful	Same as above.		
INLA				
Phase I	N/A	Did not attempt.		
Phase II	N/A	Did not attempt.		
CSA				
Phase I	N/A	Did not attempt.	N/A	Did not attempt.
Phase II	N/A	Did not attempt.	Unsuccessful	Low *techne* / *mētis*; non-rational tactical theories; leadership narcissism and superstition.
Phase III	Unsuccessful	Ideologically-driven lack of perseverance; small talent pool; forced operational tempo; leadership narcissism and superstition.	Unsuccessful	Same as above.
Order				
Phase I	N/A	Did not attempt.	N/A	Did not attempt.
Phase II	N/A	Did not attempt.	Unsuccessful	No opportunity to succeed before dissolution; poor tradecraft; low *techne*; dependent for survival on single leader.

Apart from the model, the cases themselves have substantially increased our understanding of weapons adoption. While one must not read too much into a limited number of cases, the qualitative analysis highlights several salient factors, including social networks as avenues for awareness, organizational stability, possessing a talent pool that manifests sufficient *techne* and *mētis* with respect to the weapons to be adopted, and the basic underlying driver of a perceived performance gap. Overall, even four case studies have verified that many of the factors identified in the theoretical discussion act on real-world terrorist weapons adoption processes. Perhaps the central takeaway from the case studies, however, is that the basic processes of weapons adoption are indeed equifinite – there are many paths to awareness, several factors that can prompt the decision to pursue adoption and many ways in which an adoption attempt can fail.

Applying the Model to the Case Studies

One of the aims of conducting the case studies was to provide a preliminary test and calibration of the Terrorist Weapons Adoption Model introduced in Chapter 4. In order to apply the model to the cases, it is necessary to first operationalize the model in a format conducive to the types of data that could be found in the case studies. Taking into account that this is a preliminary application of the model, more for exploratory than rigorous validation purposes, emphasis is placed on parsimony in the operationalization process. One of the more practical solutions, and that adopted here, is to construct a series of tables for each case pair, with a separate table for each dependent variable (i.e., weapon awareness, adoption decision and adoption success). Each table can simultaneously depict the outcomes on the dependent variable and the values on the independent variables for both terrorist organizations in each case pair. Tables B.1 through B.6 in Appendix B display the results, which will be used in the analysis below.

However, before proceeding with the analysis, some notes on the generation of the tables are in order:

- Each table lists the outcome of the dependent variable on the first row adjoining the relevant organization. Each subsequent row then assesses the value of each of the independent variables associated with that dependent variable in the model. For each relevant time period, the value of the independent variable is listed, with justification for that value (where not obvious) provided in footnotes.[7]

- In the same cell as the value of the independent variable, its hypothesized effect on the dependent variable is listed, drawn from the model (see Table 4.1) in terms of a positive or negative effect (denoted by one or more '+'s or '–'s). The number of symbols denotes the rough order of magnitude of the effect and thus provides an inherent weighting between variables.
- A neutral effect is denoted by '.'; if the value of a variable is unknown or its hypothesized effect is indeterminate in certain cases, the same symbol is used, implying that indeterminate variables are assumed to have a neutral effect overall.
- For relevant variable values, if these are true at any point in the designated time period, they are regarded as being true. Similarly, the highest value for relevant variables during a given time period is used to calculate the effect.
- With respect to the awareness table, it is assumed that once the organization had become aware of the weapon, this awareness persisted and so, in the absence of countervailing evidence such as a discontinuous change in leadership, awareness scores are not calculated for subsequent periods.
- Where a group did not proceed sufficiently far along in the process, there is no need to apply the model for the subsequent dependent variables. For example, since the INLA did not decide to attempt to adopt mortars, the group would not need to be represented in the success of adoption table. Nonetheless, to provide some additional opportunities for validation, all scores are calculated and should be viewed in the sense of providing rudimentary counterfactual analysis. To prevent confusion, these scores are shown in the tables in parentheses.
- The model is only partially quantitative in the sense that several variables rely on subjective analysis and their effect will vary according to contextual factors. An example is the effect on the adoption decision of the degree of technical knowledge (*techne*) that is required to acquire and field a weapon. Whether this effect is positive or negative depends on the enthusiasm with which group decision-makers embrace a challenge, which varies according to organizational context. In this way, the model attempts at least in a basic fashion to incorporate so-called conjunctive variables which are differentially causal only in terms of particular configurations.[8]

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[7] There are roughly two hundred and fifty footnotes justifying the values in the tables. Alternative methods for representing the model thus could be expected to consume extensive space, for example if an explicit discussion of each value across all the variables was presented in narrative form. This serves as a practical justification for the choice of a tabular representation for the model applications.

[8] For more on conjunctive or configurational sets of variables, including discussion of the Boolean algebra-based Qualitative Comparative Analysis (QCA) approach, see Charles C. Ragin, *Redesigning social inquiry: Fuzzy sets and beyond* (Chicago and London: University of Chicago Press, 2008) and B.

- The application of the model also allows for some discretion with respect to weighting. For instance, if the weapon or the technology underlying it is commercially available, the model prescribes an effect of '++', but in the case where it is only partially available or limited to specific sets of commercial buyers (such as is the case with many radiological isotopes), this variable might receive a partial score of a single '+'.
- Similarly, those variables that are labelled [Linear] can have a range of effects based on the magnitude of the variable. For example, when considering the 'Weapon Techne' variable, if a weapon has extremely high technical requirements (such as a genetically engineered bio-weapon), up to three '–'s can be applied in the Adoption Success table; conversely, for a weapon requiring almost no *techne* to acquire or use (such as a commercially-produced hand grenade), the score given might be one or more '+'s.
- The final combined 'score' for each time period is calculated by an arithmetic summation of the effects for each independent variable, which is listed in the last row of the table. This is the most parsimonious aggregation method and is utilized in the absence of any evidence prescribing a more complex procedure. The inherent variable weighting accounts to some degree for different relative effects of variables.

The construction of the tables allows for a comparison of scores across groups and time periods. It also allows for a comparison between the model's predictions and the findings of the qualitative analysis. Last, while hardly determinative as to the validity of any single hypothesis, those hypotheses that are consistently undermined across time periods and groups can provide guidance as to potentially problematic hypotheses.

The table below presents a summary of the case outcomes, together with the corresponding model scores. Scores in parentheses indicate counterfactual applications of the model, since the organizations in question did not actually reach this stage in the adoption process.

Table 8.4: Model Results Summary

Group / Phase	Weapon Awareness		Adoption Decision		Adoption Success	
	Outcome	Model Score	Outcome	Model Score	Outcome	Model Score
PIRA (Mortars)						
Phase I	Aware	20	Pursued	16	Unsuccessful	9
Phase II	Aware		Continued to Pursue	26	Successful	20

Rihoux and C. Ragin (eds.), *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques* (Thousand Oaks, CA: Sage Publications, Inc., 2009).

Phase III	Aware		Continued to Pursue	25	Successful	22
Phase IV	Aware		Continued to Pursue	22	Successful	16
INLA (Mortars)						
Phase I	Aware	21	Did NOT Pursue	16	N/A	(10)
Phase II	Aware		Did NOT Pursue	4	N/A	(1)
CSA (Cyanide)						
Phase I	Not Aware	5	N/A	(1)	N/A	(4)
Phase II	Aware	25	Pursued	28	Unsuccessful	11
Phase III	Aware		Continued to Pursue	30	Unsuccessful	10
Order (Cyanide)						
Phase I	Aware	13	Did NOT Pursue	9	N/A	(5)
Phase II	Aware		Pursued (?)	20	Unsuccessful	3
CSA (Rockets)						
Phase I	Not Aware	8	N/A	(-1)	N/A	(3)
Phase II	Aware	26	Did NOT Pursue	19	N/A	(8)
Phase III	Aware		Pursued	26	Unsuccessful	8
Order (Rockets)						
Phase I	Aware	18	Did NOT Pursue	14	N/A	(7)
Phase II	Aware		Did NOT Pursue	22	N/A	(4)

PIRA-INLA Model Application

When examining the first set of case studies involving the PIRA and the INLA, we see the following:

1. **Awareness**: It was only necessary to examine in Table 8.4 the initial phases of each organization, as we can safely assume – based on the relatively short time periods involved and some continuity in membership within both organizations – that their awareness did not dissipate during the period of study. The table shows both organizations scoring quite highly on the aggregate awareness score, with similar overall scores,[9] though values of individual model factors (seen in Table B.1) differ substantially. Nonetheless, these high scores support the qualitative conclusion reached during the narrative analysis that the INLA was aware of mortars during their formative years. Table B.1 captures the qualitative results that key elements responsible for this awareness were an active search by both organizations for new weapons and (at least in the case of the INLA), prior demonstration of the utility of these weapons. The table identifies additional contributing factors that might have influenced each group's respective awareness of mortars, such as the presence of a

[9] Indeed, the INLA has a slightly higher awareness score than the PIRA, primarily because the INLA had the PIRA's demonstration of success with mortars as a model.

‘skunkworks’ within the PIRA and the INLA’s access to many foreign groups and some external training during the first period of its existence.

2. **Decision**: The first observation that emerges from Table 8.4 is that during their respective formative phases, both the PIRA and the INLA received the same decision scores, albeit with different outcomes. Although varying along several independent variables (such as their institutional capacity, size and the existence of previous adoptions to emulate), the scores for these cancel each other out. This interesting result suggests that the decision model may be missing one or more variables that would distinguish between the outcomes of each organization. A strong candidate for inclusion in the model is the availability of alternatives to the technology under consideration – even though the PIRA may not have been perfectly positioned to pursue mortars, the narrative analysis suggests that they did not have many (or perhaps any) alternatives to the pursuit of mortars, something that does not appear to have been the case for the INLA in the mid to late 1970s and early 1980s. An alternative explanation is that perhaps a score in the mid-teens implies that a group could go either way with respect to adoption and thus that the model is simply less informative in such cases. Table B.2 also shows that the PIRA had fairly large decision scores (in favour of adoption) in its second, third and fourth phases of mortar development, driven by its continued need to counter new British defences and the benefits of the experience it had gained during the first phase (reflected in higher *mētis*, demonstration and greater size). This accords well with the qualitative analysis of why the PIRA persisted with mortar development, although the notion of a ‘momentum’ of development developing after an initial investment in an adoption should be considered for inclusion in future iterations of the model. Likewise, the low decision score (with many negative values) during the INLA’s second period is unproblematic and supports the narrative conclusion that the INLA had so many organizational weaknesses that it simply lacked the capability to even make a decision of this magnitude, and even if it did, would have recognized this weakness and abandoned any hope of adopting mortars.

3. **Success**: Table 8.4 provides a good illustration of the PIRA’s relative success during the different phases of its mortar development program. The lowest success score is for the initial phase, during which the PIRA had no real mortar program to speak of.

This was followed by high levels of success in the second and third phases, which saw the development of the successful Mark 6 and the high-powered Mark 10 mortars respectively (together with several other technical successes with mortars). The last period (during which the Mark 15 barracks buster was developed) was also successful, but received a lower score in the model. The model appears to fairly accurately reflect the three broad areas identified in the narrative analysis – a learning culture, expertise and a safe haven as keys to success, although the model arguably underweights the importance of the existence of a safe haven to the PIRA's ultimate success. Elements in the model that contributed towards the outcome but were not reflected in the narrative analysis include the presence of network relationships (especially having a state supporter) and the role played by determination.

<u>CSA-Order Model Application</u>

Comparing the CSA and Order case studies and the application of the model to these cases, the following emerges:

1. **Awareness**: The model accurately captures the transition from a lack of awareness to awareness of both cyanide and rockets between the first and second phases for the CSA case (scores increasing from 5 to 25 and 8 to 26, respectively, in Table 8.4). The Order case has somewhat lower values for the awareness score than the CSA, but these are still well above the only instance of non-awareness scores (during the CSA's first phase). Focusing on cyanide, the model reflected the qualitative results quite closely. In the case of the CSA, the case study indicated that awareness stemmed primarily from being presented with the cyanide by Robert Miles, which itself was a result of the CSA's ideological shifts and greater enmeshment in the militaristic segments of the Christian Identity milieu. As seen in Table B.4, much of the increase in the model's awareness scores from phase 1 to phase 2 was driven by changes in variables that reflected the CSA's increasing militarization, such as ideological compatibility, possessing a dedicated weapons R&D capability, training programs and being networked with other VNSAs, together with the obvious boost given by the more direct proselytization and serendipitous acquisition of cyanide. Although the Order did not receive cyanide as a gift, both the case study and the

model emphasize the close networks with other elements of the far right and the advocacy of poisoning water supplies emanating from this quarter as key variables in their awareness of cyanide as a weapon. Similarly, in the case of rockets, many of the same variables associated with the increasing militarization of the CSA in the second phase (highlighted in the case study) also elevated the awareness score for rockets. Although the Order may have been more explicitly influenced by the discussions of rockets in the *Turner Diaries*, both organizations could draw on this text as a source of tactical inspiration, as could both be influenced by the military experience of their members. The generally lower scores associated with both types of weapons in the awareness phases for the Order as compared with the CSA is mainly due to the Order's lack of institutionalized R&D and of an organized training program. When comparing across weapon types, the across-the-board higher scores in the model for rockets as opposed to corresponding values for cyanide can be attributed to the greater observability of rockets and the existence of prior terrorist adopters of rockets (including the PIRA and several of the Palestinian terrorist groups at the time).

2. **Decision**: Table 8.4 largely mirrors the qualitative results, with one exception, discussed below. While the qualitative analysis concluded that the CSA was not aware of either rockets or cyanide as potential weapons for adoption in their first phase, the model allows us to explore the counterfactual and suggests that even if they had been aware, they would have almost certainly foregone any attempts to adopt these weapons, as indicated by the extremely low decision scores for this time period. By the second phase, however, the situation with respect to the CSA was completely different and this is reflected in the dramatically increased scores for both weapon types under consideration.

First, focusing on cyanide, the main reasons for deciding to adopt this agent that emerged from the qualitative analysis were the provision of raw poison from a trusted source, Ellison's desire to gain prestige within the far right network and the emerging ideological legitimacy of mass murder, all of which are captured in the model (as reflected in Table B.5) in such variables as proselytization, serendipitous acquisition, ideological compatibility, increased risk tolerance and cultural affinity with the entity recommending or demonstrating the use of the weapon. However, a case can be made for including the desire for prestige as a separate variable.

Elements that were not highlighted in the qualitative analysis but that also contributed to the model's high score were tied to the group's active searching for new weapons, the possession of an institutionalized R&D capability and its prior success with autarkic weapons production. Several of these may have contributed to Ellison's confidence (already buoyed by his religious faith) that, despite the CSA essentially possessing no *techne* or *mētis* with respect to using cyanide as a mass poison, he would be able to utilize the agent. This shows how the model can suggest supplemental avenues of argument that might be missed in a purely qualitative analysis.

As for the Order, although the group's actual decision to adopt cyanide as a weapon is equivocal, if they did indeed decide to do so, this only occurred during the latter stages of phase 2, and is reflected in the model by a rise in the decision score for cyanide from 9 to 20 across the phases. Despite the ideological suitability of cyanide for the group and some degree of proselytization by other elements of the far right network (although not as strongly as in the case of the CSA), for most of its operational period, the use of cyanide was incompatible with Mathews' strictly-adhered-to strategic blueprint. The importance of this variable in the qualitative findings suggests that it might be more heavily weighted in further iterations of the model. Strategic compatibility with the weapon was not the only organizational element that changed in the second phase – other variables that contributed to the rise in the decision score for cyanide were: a surfeit of resources following the Ukiah robbery; increases in group cohesiveness and a decrease in centralization following the restructuring in July 1984; Mathews' greater tolerance for risk; and the rise in the decision-making status of Bruce Pierce who was clearly a technology champion.

Second, when looking at the adoption of rockets, the score for the CSA increased from -1 to 19 between phases 1 and 2 (despite not deciding to adopt them during period 2) and then to 26 during the third period, when the CSA did try to adopt. This might suggest that by the second phase, the CSA was 'organizationally primed' to make such an adoption decision, and that they only required a few additional 'nudges' – perhaps in the form of trigger events (like the June 1984 Aryan Nations Congress after the death of Gordon Kahl) or a tactical opportunity that required rockets in particular – to move wholeheartedly to adopt rockets as weapons. Indeed, the model points in this direction, since in phase 2, many of the organizational factors hypothesized to underlie positive adoption decisions were present (as detailed in the previous paragraph with respect to cyanide). The main additional factors present in the third phase were an increase in organizational *techne* with respect to rockets in the person of Kent Yates and the need to overcome the countermeasures in place at the Federal Building. The case of the Order, however, presents some difficulty in that the model predicts that the Order would pursue rockets in much the same way as they pursued cyanide at the end of their second phase, with the decision score for rockets rising from 14 in phase 1 to 22 in phase 2.[10] This increase is due to many of the same organizational changes that were responsible for the rise in the cyanide decision score, with the one difference being that cyanide presented specific advantages in terms of mass disruption, which is where the organization was strategically headed. Acknowledging the obvious possibility that the model is misspecified in this case, another explanation is that the Order, had they endured, would have been quite willing to utilize rockets as soon as the tactical need presented itself during the sixth strategic stage of Mathews' campaign, which envisaged large-scale, guerrilla-type attacks. It is also interesting to note that, while the absolute decision score for rockets was higher than that for cyanide in phase 2, this represented a smaller percentage increase over the score in phase 1 than cyanide did.[11] This suggests the intriguing possibility that, in addition to the absolute scores in the model being indicative of changes in the dependent variables, the relative changes across organizational periods may also be relevant in drawing conclusions from the model.

One last point worth noting with respect to the decision component of the model is that, while in the awareness component the greater observability of rockets over cyanide resulted in organizations, all else being equal, being more likely to be aware of rockets than cyanide, in the decision component of the model, other factors, such as cyanide's greater stability, make the overall relative desirability of both weapons (in the absence of any specific affinities or tactical requirements) roughly equal.[12]

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[10] The overall higher scores for rockets over cyanide are attributable in the model to the demonstration effect of the use of rockets by other terrorist groups and the specific promotion of this class of weapons in the *Turner Diaries*.

[11] The increase in rocket scores from 14 to 22 between organizational phases represents a rise of 57%, while the corresponding increase for cyanide from 9 to 20 represents a rise of 122%.

[12] Adding up only the weapon-specific scores for cyanide and rockets yields 4 for both weapons. For the awareness component, the corresponding scores were 1 for cyanide and 4 for rockets.

3. **Success**: Neither the CSA nor the Order enjoyed any real success in their adoption efforts, even assuming that the Order was genuinely seeking to employ cyanide. This is reflected in the uniformly low scores across the board for the periods when adoption was attempted.[13] Moreover, the model seems to closely parallel the results of the qualitative analysis. In the case of cyanide, the model (as shown by Table B.6) captures all the advantages possessed by the CSA that emerged from the qualitative analysis, including having an institutionalized R&D capability that had produced some success in terms of adapting weapons, being highly networked in the far right extremist milieu and operating from the relative obscurity of an isolated compound. Yet, more importantly, the cognitive bias resulting from ideological beliefs, the perceived sense of urgency and the low *techne* with respect to using cyanide as a mass-casualty weapon play a major role in the low score received. Similarly, at the time that the Order may have considered using cyanide, the model reflects Mathews' increasing perceptions of urgency, security pressures, and low *techne*, but also takes into account that the decentralized nature of the Order at the time, with spatially dispersed operational elements, would have likely made any serious adoption efforts difficult, which was not considered in the qualitative analysis. One element that the model does not explicitly address is the generally poor tradecraft displayed by the Order. Although this might be considered part of the organizational *mētis*, future iterations of the model might directly address this variable.

   With respect to the CSA's attempts to adopt rockets, the model incorporated all of the general organizational advantages, together with the fact that the group also possessed a certain degree of *techne* in this area. The model also highlights similar weaknesses to those identified in the qualitative studies, including the limited size of its technical pool and an even greater cognitive bias than it displayed towards cyanide, which, in the case of rockets led to a ruinous lack of perseverance.

[13] As part of the counterfactual exercise, the success scores were calculated even for those periods where weapons adoption was not attempted, with similarly low scores obtained in these cases.

Assessing the Model's Performance

The Terrorist Weapons Adoption Model was set up to present a generalized structure for understanding the nexus between terrorist and weapon and, secondarily, to provide a means for prospectively assessing the likelihood of a terrorist organization proceeding through various stages of the weapons adoption process. It was specifically designed to reflect equifinality at all stages of adoption, a causal arrangement that has been borne out by close examination of the cases.

Evaluating the Model

Overall, the model fared extremely well across the four case studies. Table 8.4 shows that, of the thirty opportunities to test the model (across multiple time periods, four groups and three weapons) there are only two apparent inconsistencies, both of which are equivocal. Beginning with the awareness scores, the average across the six instances when awareness was achieved is 20.5, while that for the two instances where it did not is 6.5.[14] The lowest score for a group that was aware of a weapon is 13 in the case of the Order's awareness of cyanide. This provides a provisional calibration of the model, suggesting that a total awareness score of 15 or greater generally implies that a group is aware of a particular weapon.

Turning to the adoption decision, this stage was reached by all four groups and there is more variation in outcomes. These scores also generally give some guidance as to preliminary calibration of the model, with the instances in which a weapon was pursued (or continued to be pursued) having scores that average 24.1, while scores in which a weapon was not pursued average only 14. Two of these scores do, however, present some cause for closer scrutiny, namely the apparently high scores for both the CSA and the Order rocket adoption decisions in their respective second phases, despite both groups not deciding to pursue rockets at this stage. Indeed, both these scores (19 and 22, respectively) are larger than the phase I decision score for the PIRA (16), which did decide to pursue mortars. There are several possible explanations for this. The first is that the decision sub-model is slightly misspecified – either one or more of the variable

[14] For obvious reasons, counterfactual scores in parentheses are not counted in any calculations.

weightings is incorrect, the model is missing one or more important variables or there are spurious variables included that are confounding the results. The second explanation, based on the first, is that scores between fifteen and twenty four (the average for a positive adoption decision) are equivocal and imply that a group could either pursue or not pursue a particular weapon. The third explanation is rooted in the observation that, *within the domain of rocket adoption*, there is no inconsistency. In other words, all of the scores where rockets were not pursued were lower than all of those where they were. The implication of this is that the decision model may be most successful in detecting a shift towards pursuit of a weapon when it is used to compare the same group across different time periods or the same weapon across different groups.

There are no such difficulties present in the success sub-model,[15] with the average score for a successful adoption being 19.3 and for an unsuccessful adoption being only 8.2. The fact that only a single group of the four cases (the PIRA) unequivocally succeeded in adopting the weapon that they pursued may limit the generalizability of this result, however.

While carrying all the advantages of deep contextualization, assessing the model through four case studies has obvious limitations, which nonetheless warrant mention, if only to place them in perspective. The most recognizable of these is that only considering four cases (even though these attempt to reflect as much variation in the outcomes of interest and organizational characteristics as possible) limits the generalizability of the results. This is a perennial (if often undeserved) critique of case study analysis in general and is why further analysis, through additional cases or large-sample statistical methods should be undertaken in future research. One particular manifestation of this potential issue is that because the cases focused on attaining differences in outcomes and organizational characteristics, they do not exhibit variability in terms of socio-political environment – both case pairs are located in industrialized, democratic Western countries. Hence, the two variables relating to the openness and development level of the society could not be directly tested and this raises the possibility that the model might require recalibration when utilized in less-developed or more autocratic polities.

[15] This is true even when including the counterfactual scores.

Despite these limitations, the initial test against thirty relevant time periods across the four cases confirms the face validity of the model – the model predictions are overwhelmingly supported by the qualitative conclusions of the case studies. Applying the model to the case studies also provides some guidance as to how the different sub-models can be calibrated to be used in an anticipatory fashion. Yet, testing and calibrating the overall model was not the only purpose in conducting the case studies. First, the case studies can help confirm or disconfirm the salience of particular hypotheses in the model. Second, since in-depth examinations of real-world adoption processes also serve an exploratory function, the cases can identify additional variables that have not been covered in existing innovation and weapons theory.

Refining the Model

It is to this function of the cases as a means of refining the model that the study now turns. Some guidance in this regard has already emerged from comparing the model with the qualitative results, but the next step is to systematically examine the logic of the model for additional direction. The approach that has been selected is to analyse each variable value in each instance of the model independently and then to evaluate whether it supports or undermines the particular hypothesis in the sub-model. This is accomplished in practice by appending a column to each phase in Tables B.1 through B.6 and noting whether the effect predicted by the hypothesis involving that variable with respect to the sub-model outcome is consonant with the actual outcome in that case. So, for example, one hypothesis asserts that if an organization can be classed as having a culture of learning (abbreviated as a 'learning organization'), then it is more likely to make a positive adoption decision for any new weapon. If, as is the case with respect to the PIRA during its first phase, it has been established that an organization can be categorized in this way, then one checks whether the outcome was in fact positive in this case. The PIRA did decide to adopt mortars at this time, so the hypothesis is supported (in a narrow sense) in this instance, denoted by placing an 'S' in the adjoining column. Similarly, if the PIRA had not decided to adopt mortars, then the hypothesis could be said (in an equally narrow sense) to have been undermined and would thus be marked with a 'U'. Note that since the hypothesis says nothing about the converse, i.e., terrorist organizations that cannot be classified as learning organizations, if the PIRA were not a learning organization, the hypothesis could not be evaluated in this instance, denoted by placing a '.' signifier in the column. To avoid confusion, where more than one weapon is being considered, the signifier is preceded by either a 'C' or an 'R', representing cyanide and rockets respectively.

In what ways can the hypotheses really be supported or undermined using this procedure? Clearly, a hypothesis that is discordant with an actual outcome does not necessarily mean that it did not have the predicted effect on the decision process – its effect might simply have been 'drowned out' by other, more powerful or numerous countervailing factors. All that can really be tested is whether a particular variable is necessary or sufficient for a certain outcome, and since we have established that the weapons adoption process for terrorists is dominated by equifinality, we do not expect to see many necessary or sufficient variables in the first place. However, if a particular hypothesis is consistently 'undermined' by the cases using the process just described, then one might suspect that it is either indeed false, or that even if it is true, its effect does not seem to be strong enough to be determinative in any of the cases considered. The latter would imply that even if the hypothesis is a genuine reflection of reality, it is not a very useful indicator in any case. In either of these circumstances, the hypothesis at least warrants reconsideration and if, upon further investigation of the context in which it operated there are no extenuating circumstances that might explain its lack of support, then the hypothesis can be shortlisted for modification or removal from the model, pending additional empirical research.

In following the abovementioned procedure, criteria were needed for when to flag a variable for further consideration, since most of the variables had at least one instance where they were undermined. Owing to the limited number of cases and the issue of equifinality, a fairly conservative approach was taken, in other words setting a reasonably high bar for placing a hypothesis 'on notice' so to speak. The first criterion was that the hypothesis had to be sufficiently evaluated – only a handful of instances of being undermined would not be enough to discredit a hypothesis. The minimum number of hypotheses varied according to the number of opportunities presented across the cases for evaluation. For example, the awareness sub-model had only eight opportunities to test the hypotheses, and thus at least three evaluations of a hypothesis were required to question it, whereas the decision sub-model had fourteen chances to be evaluated, so the corresponding criterion was set at five evaluations. The second criterion was that a hypothesis could not be questioned if the number of supporting evaluations was greater than or nearly equal to the number of undermining evaluations (i.e., the number of 'U's for a particular variable had to be more than one greater than the number of 'S's). After evaluating each of the 138 separate hypotheses in the model across all organizations, time periods and weapons (see Tables B.1 through B.6 for details), the variables representing the sixteen hypotheses that met the above criteria are listed in Table 8.5 below. These are the variables that require further consideration to see whether they should be modified or even retained in the model at all. Table 8.5 provides a brief discussion of the investigation into these hypotheses and the recommended course of action with respect to the model.

Based on Table 8.5 and the previous qualitative analysis, the following elements are singled out for modification in the initial model:

Awareness Sub-Model

- Removal of the '*techne* required to acquire / field the weapon' variable from the model.[16]
- Modification of the 'perception of urgency' variable to 'perception of extreme urgency'.

Decision Sub-Model

- Addition of a variable labelled 'availability of alternatives to weapons technology under consideration', reflecting the hypothesis that few or no alternatives make a positive decision significantly more likely.
- Addition of a variable labelled 'momentum', which applies after an initial period of adoption and makes continued adoption of the same weapon more likely.
- Addition of a variable labelled 'desire for prestige', reflecting the hypothesis that if a leader desires personal prestige amongst other group members, other

[16] This variable should still be tested in future empirical evaluations of the model, in order to establish whether and under what circumstances it can have a positive effect on awareness.

organizations or constituencies, then this makes a decision to adopt a new weapon more likely.

- Modification of the 'strategic compatibility' variable to make it linear, i.e., if the weapon is not compatible with the organization's current strategy, then it makes a positive adoption decision less likely.
- Modification of the 'perception of urgency' variable to 'perception of extreme urgency' and allow it to take on the values of '~ to – –', dependent on the length of the development cycle of the weapon. This reflects the hypothesis that only when there is a perception on the part of group leaders that there is extreme urgency and that this urgency needs to manifest itself in more frequent operations, will this be a deterrent to adoption.
- Modification of the 'security pressures' variable to 'intense security pressures' to raise the evidentiary bar for allowing this variable to negatively affect the adoption decision.
- Modification of the 'number of prior adopters' variable to reflect that the greater the number of prior adopters, the more likely adoption becomes (to a given extent), but that no prior adopters does not prejudice the adoption decision in any way.
- Modification of the 'guardians of the status quo variable' to no longer have a linear effect, but to only have a negative effect if present.

Success Sub-Model

- Removal of the 'champion in leadership' variable from the success sub-model.
- Tentative addition of a variable for 'general tradecraft' (distinguished from organizational *mētis*) to reflect the hypothesis that poor general tradecraft should negatively affect the probability of a successful adoption of a weapon.[17]

The relevance of the model (including these suggested changes) will be visited in the conclusion.

[17] The PIRA case study suggested that a safe haven might be more heavily weighted, but the lack of support for this variable in the other cases implies that this would be premature.

Table 8.5: Suggested Modifications to the Terrorist Weapons Adoption Model

Sub Model / Variable	Hypothesis Evaluation	Discussion
Awareness	**[Criteria: Total number of evaluations ≥ 3; Number of U's – Number of S's >1]**	
Cognitive Biases	Supporting: 0 Undermining: 3	Upon examination, the negative effect of these biases in the INLA and Order cases was, if anything, extremely small and not enough to prevent awareness; in other cases, there may be a greater effect. *Recommendation: premature to remove from the model at this stage.*
Techne Weapon	Supporting: 1 Undermining: 4	There is no qualitative evidence that the *techne* required to acquire/field the weapon affected awareness (even in the supportive case), and may in fact have had the opposite effect of increasing awareness in some cases. *Recommendation: remove from model (or even allow the variable to take on positive values based on further empirical evidence)*.
Perceived Urgency	Supporting: 0 Undermining: 3	There are only three evaluations, but in none of these was the level of urgency sufficiently high to be expected to affect awareness. *Recommendation: Modify variable to 'perception of extreme urgency to act'.*
Decision	**[Criteria: Total number of evaluations ≥ 5; Number of U's – Number of S's >1]**	
Perceived Urgency	Supporting: 1 Undermining: 6	This result is mainly due to the CSA exhibiting this factor, but in that case the perceived urgency was not very high. The variable should capture not just whether or not the group wants to act, but whether it feels an intense pressure to operate at a high pace. *Recommendation: Modify variable to 'perception of extreme urgency to act' and allow it to take on the values of '~ to - -', dependent on the length of the development cycle of the weapon.*
Number of weapons needed / desired	Supporting: 2 Undermining: 5	Only a small effect is predicted, thus this may have been drowned out in the cases; also it is a theoretically persuasive argument. *Recommendation: retain in model pending further empirical research*.
Number of Successful Prior Adopters	Supporting: 1 Undermining: 5	The results argue for a recalibration. *Recommendation: Allow the variable to take on the values of '~ to ++', depending on the number of prior adopters. No or one prior adopter = ~; Handful of prior adopters = +; only if many, then = + +.*
Security Pressures	Supporting: 3 Undermining: 5	Since almost all terrorist organizations experience some security pressures, this variable would function better if better specified. *Recommendation: Modify variable to 'INTENSE security pressures', in other words, greater than traditional law enforcement and intelligence efforts.*
Presence of Guardians of the Status Quo	Supporting: 4 Undermining: 6	*Recommendation*: *Variable should not be linear in its effect: if one or more guardians present, its effect should be '-'; if absent, a '~'.*
Success [Criteria: Total number of evaluations ≥ 4; Number of U's – Number of S's >1]		
Social / Political Openness	Supporting: 0 Undermining: 4	Since there was no variation within this variable in the case studies, it would be premature to exclude it. (It was tacitly supported for the PIRA, but did not have an effect so was not counted). *Recommendation: Retain, pending further empirical evidence.*
Societal Infrastructure (Development)	Supporting: 3 Undermining: 5	Same as above.
Centralization	Supporting: 1 Undermining: 4	The PIRA only exhibited moderate centralization, so the results are based only on the CSA case, which could be an outlier. *Recommendation: Retain, pending further empirical evidence.*
Mētis Required to Develop / Field the Weapon	Supporting: 2 Undermining: 6	Much of the undermining of the hypothesis is driven by the PIRA case. It is suspected that this variable should not be evaluated in isolation, but should be compared to the organizational metis. When the two variables are interacted (Mētis Weapon is added to Mētis Organization), the hypothesis is confirmed in all cases (similar case with *techne* variables). *Recommendation: Retain variable, but evaluate together with organizational counterpart.*

Commercialized Technology	Supporting: 3 Undermining: 5	The variable was only partially fulfilled for all cases, so conclusions cannot be drawn from this set of case studies. *Recommendation: Retain, pending further empirical evidence.*
Champion in Leadership	Supporting: 0 Undermining: 4	Upon investigation of the cases, it is clear that while an innovation champion is consequential in the decision whether to adopt, it has little bearing on the success of adoption. *Recommendation: Exclude variable from Success sub-model*.
Technology Maturity Cycle	Supporting: 3 Undermining: 5	An insufficient number of weapons was tested, so it is premature to exclude this variable. *Recommendation: Retain, pending further empirical evidence.*
Safe Haven	Supporting: 2 Undermining: 4	In the last period of the PIRA, the group probably still had some safe havens in the Republic of Ireland, but the variable was coded conservatively. If indeed the PIRA did have a safe haven during this period, there would be insufficient evidence to exclude this variable. *Recommendation: Retain, pending further empirical evidence.*

Chapter 9: Conclusion

> *Our future is in our own hands, to make or to mar. It will be an uphill fight to the end, and would we have it otherwise? Let no one suppose that evolution will ever exempt us from struggles. 'You forget,' said the Devil, with a chuckle, 'that I have been evolving too.' - William Ralph Inge*[1]

It has become almost trite to say that we live in a technological age. Many observers then proceed to evoke one or more of the shiny new gadgets, from smartphones to robotic vacuum cleaners, that are the quotidian technological emblems of the 21st century. The implications of technological advancement go far beyond these superficial accoutrements, however, and scholars have only just begun to reflect on a world in which the social, economic, cultural, and scientific spheres are becoming dominated by complex tools that we have created but often barely understand. Considering the far-reaching societal effects wrought by previous technological transformations like the Industrial Revolution, the astounding velocity of contemporary technological change presages major shifts in global civilization. After all, technology not only breaks new boundaries in the physical world, but also empowers individuals and groups and democratizes and amplifies knowledge.

Those tasked with thinking about security, however, fear that modern technology will do the same for those asymmetric adversaries – terrorists chief amongst them – who would use technology as weapons, to destroy rather than to create. Thus is established a conceptual linkage between the terrorist threat and emerging technology. Yet, this linkage is empirically tenuous, for historically only a small subset of terrorists have been particularly innovative when it comes to their pursuit of weapons and, conversely, most technological breakthroughs with the potential to cause harm have not been swept up by terrorists as soon as they made their appearance. This study has sought to unravel one of the theoretical and empirical threads linking terrorists and technology by exploring how and when terrorists adopt new weapons. It has approached this from two different perspectives, traversing theories and experience in several domains. First, in what this study has characterized as an 'outside in' orientation, the study examined the historical adoption of weapons by a variety of actors, from primitive humans to modern militaries. The second source of insights, reflecting an 'inside out' orientation, sprang from the scholarship on organizational innovation and learning, primarily that

[1] Quoted in Tom Crisp (ed.), *The Book of Bill: Choice Words, Memorable Men* (Kansas City, MI: Andrews McMeel Publishing, 2009), p. 99.

pertaining to terrorist groups, but ranging more broadly when necessary to other organizational entities like firms and government agencies.

The result was the identification of a complex web of factors that might influence the three main stages of terrorist weapons adoption – awareness of a new weapon or weapons-relevant technology, the decision (or lack thereof) to adopt or refrain from adopting, and the success or otherwise of an attempt to adopt. Terrorists must successfully pass through each of these gateways if they are to acquire a new, and presumably more potent, weapons capability. This set of diverse influencing factors was distilled down to a framework representing a highly contingent interaction between the terrorist organization and the prospective weapon in a particular social, political, and security setting, all of which is coloured by the organization's prior experiences and current perceptions. The framework was then embedded in a Terrorist Weapons Adoption Model, which dealt separately with each adoption stage and reflected the hypothesized effects of each contributing factor.

In order to supplement and provide a preliminary validation of the model, it was exposed to real-world cases of the terrorist weapons adoption process. The adoption behaviour of four different terrorist organizations was analysed, with the cases carefully selected to provide maximum inferential leverage, both within cases (since each group's behaviour was studied over time) and comparatively across both related and different contexts. The cases largely confirmed the central strategic and tactical logic of weapons adoption, as well as highlighted the crucial role played by a variety of contingent factors, from ideology to the terrorists' social networks. The model also fared surprisingly well against the empirical data; the cases suggested a handful of modifications, but many of the hypotheses were supported by the evidence and, overall, the model accurately predicted most of the key outcomes reflected in the cases. Some of the more important and novel insights about the weapons adoption process that emerged from the model and cases are summarized below.

In terms of gaining awareness of potential weapons or related technologies as candidates for adoption, this tends to arise fairly rapidly after a group makes the decision to engage in violence, irrespective of the group's outlook or capability. Even the significantly isolated CSA had no problem keeping abreast of options for new weapons. Turning to the main theorized awareness mechanisms, namely active searching, demonstration and proselytization, we see that each played a significant role in at least one terrorist group becoming aware of a weapon, thus validating the categorization schema. As for the source of the awareness, 'word of mouth' across existing social and ideological networks appears to be a particularly important channel through which awareness of a weapon can flow. In this context, the prior weapons experiences of group members or like-minded violent organizations in the group's milieu and even the written prescriptions of movement ideologues can garner the attention of group decision-makers. A key corollary, at least for military armaments, is the part played by group members with previous military expertise in facilitating a terrorist organization's awareness of candidate weapons. The study also confirms that if there are salient group members who are positively predisposed towards the notion of innovation in general, awareness of any particular weapon becomes more likely. Last, with respect to the nature of the weapon itself, the case evidence supports the theoretical contention that, all else being equal, the more easily observable a weapon's operation and effects are, the greater the likelihood of a terrorist group becoming aware of that weapon.

Turning to influences on the decision to adopt the candidate weapon, the cases collectively confirm the basic logic of innovation adoption – that a new weapon is generally sought by terrorists when they perceive a tactical or strategic gap in performance that cannot be addressed by their existing arsenal. The cases also demonstrate clearly that simply providing perceived advantages over the status quo is not enough; the devil is in the details and there are a host of other influences that come into play in the adoption decision. First, the cases point to three preconditions as being crucial: compatibility of the new weapon with the organization's overall strategy as well as its ideology, and a sufficient level of internal cohesiveness for a decision to be made and implemented. Second, among the perceived strategic factors that can stimulate adoption of new weapons, the anticipated prestige that adoption might provide for the terrorist leaders or the group as a whole with respect to either internal or external audiences should not be overlooked. Other factors that the case evidence indicates make a positive adoption decision more likely include a fairly high tolerance for risk on behalf of group decision-makers, the possession by the terrorist organization of a safe haven where it can operate relatively undisturbed, and the prior institutionalization in the organization of a ‘skunkworks’ or other dedicated research and development capability. Having a larger membership overall, and especially a sizeable cadre with technical expertise, are also associated in the cases with decision-makers opting to pursue a new weapon. Factors that appear to make the choice of a specific type of weapon more likely include a limited availability of alternatives to the weapon under consideration, the amount of information available about the weapon or technology overall and serendipitous acquisition, where the terrorists are presented with a specific weapon with little to no effort required on their part. Third, the cases support the contention that there is a certain momentum to weapons adoption; if an organization had already developed the infrastructure and sunk the resources into developing or acquiring a new weapon in the past, it was more likely to continue to pursue adoption of new weapons, not only updated versions of the previously adopted weapon, but completely new platforms as well.

The most obvious discriminating determinant between adoption success and failure is whether the terrorist organization possesses, or is able to develop, the requisite levels of *techne* and *mētis* within the organization to produce or acquire, and use, the particular weapons technology pursued. This finding is supported by all the cases where it applies. It goes almost without saying that the less complex and unfamiliar the weapons technology is, the greater the chances are that a given terrorist group will fulfil this criterion. Several ancillary factors increase the likelihood that the necessary levels of *techne* and *mētis* will be present or attained. These include having a sizeable talent pool of experts, prior experience in adopting or producing technology, a safe haven in which to operate, significant resources, a dedicated R&D apparatus, and an overall organizational culture of learning. Maintaining extensive network relationships with other entities through which to acquire resources or expertise can also bolster a terrorist group’s prospects for successful adoption of a weapon. An important caveat to all of this is that ideological and other cognitive biases on the part of group decision-makers can negate almost all of these advantages; among the cases, the CSA failed in its weapons adoption primarily because its leader’s eccentric beliefs resulted in the organization both not realizing the degree of *techne* (let alone *mētis*) that was needed for one weapon and prematurely giving up on acquiring the expertise needed for another.

Although the case studies were selected and structured to yield as much comparative and longitudinal insight and to provide as robust a validation of the model as possible, there are inherent limitations on the generalizability of results obtained from focusing on only four cases, which covered only two extremist ideologies and only three different weapons technologies (two of which are closely related). There are therefore several opportunities for continued future research. First, while the cases studied provided explicit tests for many of the constituent hypotheses of the model, there were also several hypotheses for which the cases did not provide direct guidance, such as when a variable was not present in a case or the value of the variable was not known. Conducting additional cases would thus in general serve as a means of directly confirming (or disconfirming) the relevance of a greater number of variables and further refining the model, thereby increasing the model's saliency and parsimony. Second, with respect to the type of additional case studies that might be conducted, while the studies reflect variation in terms of perpetrator ideologies and national backgrounds, all the cases took place in developed, Western countries. Future tests of the theory and model would usefully be situated in less-developed polities and cultures that do not have their antecedents in the Western liberal tradition. This would explicitly address the impact of the broader societal influence variables in particular, investigating whether, just as with many a worthy tale, the setting is just as much an element of the drama as the actions of the protagonists. Third, as noted in the introductory chapter, the effect of emerging technologies raises particular concern when it comes to so-called WMD. While one of the weapons studied (cyanide as a mass-casualty weapon) does fall into this category, and the illustrative application of the model to emerging technology provided below also pertains to this class of weapons, the historical cases did not directly reflect the impact of major technological changes in this regard. There may thus be considerable utility to a follow-up study in which the model is examined specifically in light of the organizational incentives and sometimes unique weapons characteristics of WMD.[2] Last, the current study focuses only on terrorist organizations, but there is no

[2] This might enable the assessment of whether WMD in the terrorism context act as so-called 'disruptive innovations', innovations that eventually simultaneously fulfill the minimum requirements along traditional demand categories (for example, for some terrorists, the number of casualties per unit resources expended) and offer something new to potential adopters that existing technologies or practices do not (say, greater ease of use or psychological impact on the target society). See Christensen, et. al., passim and Erwin Danneels, 'Disruptive Technology Reconsidered: A Critique and Research Agenda', *Journal of Product Innovation Management*, 21 (2004), pp. 246-258). The most important aspect of disruptive innovations is that they can rapidly and permanently displace established technologies after a critical point in their performance trajectories has been reached; the adoption by terrorists of WMD might reach a tipping point, after which the use of these technologies might rapidly become much more

inherent reason why the adoption of weapons by non-state actors could not be analysed more broadly. Potentially fruitful avenues of future research could thus be to apply the basic approach to other forms and types of actor, including so-called 'lone wolves'[3] and groups in more traditional (i.e., non-terrorist based) insurgencies. This would necessitate some modifications to the model, however, especially where certain hypotheses and variables no longer apply. Despite the clear need for investigation of additional, more varied cases before any claims can be made about the universality of the findings about weapons adoption by violent non-state actors, the current study has provided both a theoretical and methodological template for ensuing research and will thus considerably facilitate future endeavours in this regard.

Overall, an important part of what has been accomplished through this study has been to show, both empirically and theoretically, that a terrorist group's organizational attributes matter at least as much as the technological attributes of a candidate weapon when it comes to the question of whether the terrorist group will pursue that weapon and succeed in doing so. In fact, it appears that the relationship between terrorists and new weapons is far more reflexive than is often assumed – while the physical and technological characteristics of a weapon are important, it is only in how these are reflected in and measured against the organization's ideological, strategic and logistic outlook that the weapon's attributes really influence the group's awareness, decision-making and likelihood of adoption success. In terms of the dynamics introduced in the opening chapter this implies that the 'push' dynamic, which emphasizes factors arising within the terrorist organization, is at least as, if not more, important than the 'pull' dynamic in terms of the overall threat posed by terrorism, especially in the short term. For, if a terrorist organization is not primed to be aware of new technologies, is not in an innovative organizational posture and does not possess the capabilities to take advantage of a new weapons technology, it is very unlikely to make it through all three of the procedural gates needed to adopt and utilize the technology.

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widespread (see also Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference* (Boston: Back Bay Books, 2002)).

[3] In this context, lone wolf terrorists could be construed as 'superempowered individuals'; see John Robb, *Brave New War: The Next Stage of Terrorism and the End of Globalization* (Hoboken, New Jersey: John Wiley & Sons, 2007), p.8; Adam Elkus,'Night of the Lone Wolves' *Defense and National Interest* (28 November 2007).

Terrorist weapons usage is thus likely to continue to display a certain 'stickiness' or inertia in the face of even today's rapidly emerging technologies, with the vast majority of terrorist organizations being unwilling or unable to jump on the latest technological bandwagon. This is not to say that the 'pull' dynamic should be ignored. The case studies also indicate that there will likely always be some terrorists, like the PIRA, with the right set of organizational capacities and incentives to become seekers and early adopters of new weapons technologies. The Terrorist Weapons Adoption Model in turn suggests that once adoption by even one terrorist organization has been successful, demonstration and network effects make the next adoption that much easier. For innovative terrorists, who are likely to already be paying close attention, even relatively minor changes in the technologies themselves in terms of their performance, ease of acquisition, and so forth, might tip the balance in favour of an acquisition attempt or success. In the longer term, as new technologies mature and one or more maverick terrorists 'try them on' as weapons, the threat thus increases. From a counterterrorism perspective, then, the key question becomes less about what the new technologies do than about which terrorists are likely to exploit such technologies first.

Illustrative Application of the Model

In order to demonstrate how the Terrorist Weapons Adoption Model might be utilized in practice, an illustrative application of the model (as refined in Chapter 8) is presented below. It should be noted at the outset that since this exercise is intended for illustrative purposes only, the model inputs have not been rigorously researched and justified.[4] The two emerging technologies with weapons potential that will be examined are chemical microreactors and rapid prototyping. As mentioned in the introductory chapter, microreactors can allow for the controlled mixing of even highly toxic chemicals, conceivably making the production of chemical weapons such as sarin or VX nerve agents safer and yielding less of a footprint.[5] Rapid prototyping technologies, popularly referred to as '3D printing', allow for even complex real-world objects to be rapidly

[4] The author does, however, have extensive experience researching all three of the organizations examined and supplied his best estimates of the values of each variable based on his existing knowledge of each group, thus making the results at the very least a plausible approximation.
[5] See, for example, Smithson, pp. 80-81; Patrick L. Mills, David J. Quiram and James F. Ryley, 'Microreactor Technology and Process Miniaturization for Catalytic Reactions—A Perspective on Recent Developments and Emerging Technologies', *Chemical Engineering Science* 62 (2007), pp. 6992-7010; and Tuan H. Nguyen, 'Microchallenges of Chemical Weapons Proliferation', *Science*, 309:5737 (12 August 2005), pp. 1021.

produced (usually through selective deposition techniques) from computer models, and the concern is that they might obviate the need for terrorists and other non-state actors to undertake the onerous and highly-skilled task of machining precise parts for use in explosives or other weapons.[6] It may even be conceivable in the near future for terrorists to 'print' entire bombs (including the explosive components) from plans that could be sent over the internet to even inexperienced operatives. It should be emphasized that these, like most emerging technologies, have legitimate, non-violent uses that hold tremendous value for the betterment of humanity. Indeed, the overwhelming majority of users of these technologies are likely to do so for productive, beneficial or at least benign purposes, ranging from new commercial processes and pharmaceuticals that conquer age-old diseases to tinkering by hobbyists. This immediately raises a dual-use dilemma in that the tremendous benefits to society need to be weighed against the baleful consequences of the potential misuse of these technologies by a relatively tiny minority.

The terrorist organizations that are considered in this example are the central core of al-Qa'ida, currently headed by Ayman al-Zawahiri and thought to be based in northwestern Pakistan, Hizb'allah, the Lebanese Shi'ite militant and political organization, and an American apocalyptic-millenarian cult (modelled along the lines of Aum Shinrikyo) that is headed by an idiosyncratic leader who has a fascination with chemical weapons. The demonstration consists of applying the model (as described in Chapter 8) to each of these organizations for each of the two emerging technologies. The application will also consider the adoption of improvised explosive devices (IEDs) – which both al-Qa'ida and Hizb'allah have already adopted in the past – as a calibration mechanism and control. The diversity of weapons and organizations should suffice to adequately illustrate the use and potential of the model. The full application of the model is provided in Appendix C, Tables C.1 to C.4, with the summary results presented below in Table 9.1.

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[6] See, *inter alia*, Joseph Flaherty, 'Looks Could Kill: Using 3-D Printers to Design Guns', *Wired* (20 August 2012), accessed at: http://www.wired.com/design/2012/08/rapid-fire-rapid-prototypes/ on 2 November 2013; Jamais Cascio, Open the Future Blog (24 July 2006). Accessed at: http://www.openthefuture.com/2006/07/monday_topsight_july_24_2006.html on 2 November 2013; and Gefang Wang, et. al., 'Application of Rapid Prototyping Technology in Equipment Parts Rapid Manufacturing', *3rd International Conference on System Science, Engineering Design and Manufacturing Informatization*, 2012. Accessed at: http://ieeexplore.ieee.org/xpl/abstractAuthors.jsp?tp=&arnumber=6340744&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6340744, on 2 November 2013.

Table 9.1: Summary Results of Illustrative Model Application

Adoption Phase	Weapon	Scores		
		AQ Central	Hizb'allah	Apocalyptic Cult
Awareness	IEDs	15.5	28	19
	Chemical Microreactors	7	19	19
	Rapid Prototyping	6	21.5	15
Decision	IEDs	27.5	31	15
	Chemical Microreactors	17	18.5	26.5
	Rapid Prototyping	11.5	21	19
Success	IEDs	17	26	10
	Chemical Microreactors	7.5	14.5	9.5
	Rapid Prototyping	5	17	6

As displayed in the table, if one takes al-Qa'ida's known awareness of IEDs as the benchmark score for awareness, all three organizations are likely to have awareness of this weapon, as expected. Hizb'allah has the greatest awareness of the two emerging technologies overall, with the apocalyptic-millenarian cult having lower awareness scores generally than the Shiite group but equal in terms of microreactors and still comparable to the benchmark. However, the model suggests that, especially in light of its weakened position and the intense security threats it is currently facing, primarily in the form of unmanned 'drones', al-Qa'ida central may not even be aware of the potential weapons utility of microreactors or rapid prototyping. It should be noted that the discrepancy between groups is almost solely due to non-weapons related factors, since Table C.2 shows that the purely weapons-related awareness scores are similar across the three weapons.

With respect to the adoption decision, on the basis of only the characteristics that pertain to the weapons or technologies, microreactors are by far the most attractive technology of the three, yet the model predicts a variety of relative preferences across the technologies. Even if it were aware of the other potential weapons technologies, according to the model al-Qa'ida is likely to choose to favour IEDs over the emerging technologies, although microreactors would have some latent degree of attractiveness to the group. Hizb'allah is also most likely to maintain its usage of IEDs and related weapons, but in this case, rapid prototyping and even microreactor technology do not lag far behind in the model. The model suggests, therefore, that relatively minor changes (e.g., demonstration of rapid prototyping in a weapons context by another organization, a lower acquisition cost, or an increase in the group's *mētis* as the technology becomes more widely used) could precipitate an attempt to adopt rapid prototyping technology. The apocalyptic-millenarian cult clearly favours adopting microreactors, mainly driven by its leader's affinity for chemical weapons, but also because of its general predilection for innovation and the high level of technical expertise among its membership. Again, although an intuitive result was obtained in this case, the model considered multiple factors that might have disincentivized the group from adopting microreactors relative to the other two weapons and established that these did not override the strong push and pull factors towards adopting microreactors.

In terms of success, al-Qa'ida is much less likely to succeed with either of the emerging technologies, when compared with IEDs, while Hizb'allah has relatively high scores across the board, especially with respect to rapid prototyping when it comes to the emerging technologies. Although the model shows that the apocalyptic-millenarian cult is more likely to succeed in adopting IEDs and microreactors than rapid prototyping, it is far behind Hizb'allah's scores in all weapon types.

From the perspective of a counterterrorism policymaker or practitioner, the results of the model indicate that of the three organizations considered, the greatest threat with respect to these two emerging technologies lies with Hizb'allah, especially relating to its possible use of rapid prototyping technologies. The apocalyptic-millenarian cult certainly has the willingness to pursue using microreactors to develop chemical weapons. Although its capability to do so is somewhat constrained at present, it nonetheless bears close monitoring in case its adoption capacity increases. In this regard, in addition to providing practitioners with a means to prioritize and focus its counterterrorism and counterproliferation efforts, one advantage of using the model is that it provides a mechanism for continuing to evaluate the weapons adoption process of a given terrorist group or with respect to a particular technology over time. In other words, once the model has been applied to a particular organization, it is relatively easy to track and evaluate the importance of changes in the organization and its operating environment, as well as to analyse new technologies or the evolution of existing ones, by simply updating those variables that are changing and recalculating the model.

Policy Implications and Recommendations

The implications of the study's findings for counterterrorism policy and practice are severalfold. At the broadest policy level, since there are multiple failure points along a terrorist organization's road to weapons adoption success, much of the hyperbole that sometimes attends the unveiling of a new technological breakthrough is misplaced. The technology may very well present terrorists and other malevolent actors with new opportunities, but that is only the first step in assessing the actual danger and policymakers should not jump to conclusions about the terrorist threat posed by the technology, at least in the short term, before conducting an analysis of whether extant terrorist groups are even likely to be interested in, let alone capable of, exploiting the new technology.

This study and the model it has produced might thus hold some utility for addressing the so-called dual-use dilemma exhibited by many emerging technologies. Rather than imposing blanket restrictions on all new technologies that might pose some danger, which would no doubt become a Sisyphean, if not downright counterproductive, task, the insights gained through this study can assist policymakers by identifying the technology-organization dyads of greatest concern and thereby prioritizing technology control and non-proliferation efforts. If, for example, a given new technology provides several performance advantages for terrorists, but is likely to be successfully adopted only by at most one or two extant organizations, then in the short term at least, it makes more sense to focus on constraining and negating the relevant organizations, rather than controlling the spread of the technology. On the other hand, if the new technology not only provides inherent tactical benefits, but is likely to be attractive to and rapidly adopted by a multiplicity of terrorist organization, that technology might be prioritized for control efforts. It should be borne in mind, of course, that emerging technologies can also contribute to the defence and amplify the capabilities of counterterrorism agencies and thus that the risks of a new technology in terms of its use in a terrorist weapon must be measured relative to its defensive benefits (not to mention those in other social domains), although the details of this are a matter for a different study.

At the same time, the study has indicated that it is likely to be more difficult to prevent terrorist awareness of a new technology and its weapons potential. Even in the case studies, which took place prior to the advent of the Internet, terrorists quickly became aware of new means of destruction, either from open information sources or from other nodes in their respective networks. As a consequence, any government attempt to keep the existence of emerging technology secret is unlikely to work and, in fact, may be counterproductive in the sense of attracting terrorists' attention by lending the technology the allure of the forbidden.

A better strategy might be to monitor more closely those organizations with the motivation and capability to exploit these technologies, in search of indications of their interest, once again arguing for a focus on organizations in conjunction with technologies, rather than on the technologies in isolation. Of course, efforts should still be made to limit the availability to malefactors of the precise *techne* (and even more importantly *mētis*) surrounding adoption of a dangerous new technology. In practical terms this argues that in cases such as the recent controversy surrounding the publication of studies increasing the virulence of the influenza virus,[7] the results of the research should be published widely, but not necessarily the detailed blueprints for making the virus more deadly. The centrality of *techne* and *mētis* to adoption success also validates to some extent the contention that it is easier for a scientist to become a terrorist than for a terrorist to become a scientist,[8] thus placing renewed focus on issues of personnel reliability.

The most important contribution of the current study is perhaps to be found in the more operational counterterrorism context. In addition to functioning as a means of scholarly investigation, the Terrorist Weapons Adoption Model (or a future, more refined, iteration thereof) can be used as an analytical tool to assist practitioners in identifying which terrorist adversaries are likely to pursue and successfully adopt emerging technologies as weapons. It can thereby allow counterterrorism authorities to prioritize resources towards monitoring and countering those organizations that pose the greatest threat in this regard. It is important to recognize that the model, even when applied to

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[7] For example, see Simon Wain-Hobson, 'H5N1 viral-engineering dangers will not go away', *Nature* (27 March 2013). Accessed at http://www.nature.com/news/h5n1-viral-engineering-dangers-will-not-go-away-1.12677 on 27 October 2013.
[8] For a discussion of this in the context of bioterrorism, see *New Horizons in Bioterrorism Workshop Report* (Boston: National Security Innovations and START, 17 September 2008), p. 30.

historical case studies, utilizes observable or inferable attributes of an organization to make analytical forecasts about the organization's adoption behaviour. It is thus eminently suitable for use by intelligence and other national security analysts. Those analysts familiar with a particular terrorist organization can input what they already know or are observing with respect to the organization, and the model will assist in accounting for the myriad influences on adoption behaviour and can provide guidance on the likelihood of the organization passing through the various stages of adoption. The model is likely to be most useful when applied periodically, as it seems most accurate in detecting likely changes in group behaviour over time. The model can, of course, also be applied to a range of organizations when a new technology of concern presents itself in order to determine which organization is most likely to pursue and succeed at adoption.

The problem with most threat assessments is that no sooner has the proverbial ink dried on a fixed analysis than many of the observations upon which it relies begin to become outdated in light of constantly evolving terrorist strategies, tactics, ideologies and skills, as well as synergistic changes in the broader terrorist eco-system. If this necessitates beginning an assessment from scratch with each change, an analyst is unlikely to invest the time and effort to constantly revisit and update an assessment. In the case of the model presented here, however, longitudinal change is explicitly built in (as shown in the case studies and application) and an analyst merely needs to update the relevant variables and perform a quick recalculation.

Paul Wilkinson has bluntly stated that 'the terrorist almost invariably has the inestimable advantage of surprise'[9] and other scholars have bemoaned the fact that 'the terrorists' own operational ingenuity has enabled at least some groups to stay constantly ahead of the counter-terrorist technology curve.'[10] By employing a future version of the model as an analytical tool, counterterrorism practitioners will hopefully be able to reduce the chances of surprise and mitigate the terrorist advantage, at least with respect to the adoption of a new weapon.

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[9] Wilkinson, p. 6.
[10] Hoffman, 'Terrorist Targeting', p. 19.

This study has elucidated the behavioural mechanisms behind changes in the instruments of terror by exploring terrorist selection and pursuit of weapons in light of a variety of organizational shifts, security force countermeasures and, in particular, technological developments in the broader society. In so doing, it has touched upon deeper currents in human history, diving into the tumultuous confluence of forces ideological and technological, the thrashing together of human will and human artifice. The main theoretical result has been the rejection of determinism in the terrorist adoption of new weapons and technology and the confirmation of contingency and equifinality in the adoption process.[11] After all, as the historian Joel Mokyr has so deftly observed, technology 'opens doors; it does not force society to walk through them'.[12] Yet, as evoked by the quotation that opens this chapter, terrorists can on occasion be inherently adaptive and even innovative. As a result, at least some terrorist organizations will attempt, and a subset of these may even succeed, in exploiting the extraordinary technological developments that the modern world presents. The second major contribution of this study, the model of terrorist weapons adoption it has produced, can serve as the basis for identifying and thus interdicting these terrorist adepts before they have the opportunity to rain destruction upon an unsuspecting citizenry.

[11] Paul Wilkinson notes this in his own compilation of papers on terrorism and technology, and adds that 'So much depends on the ability and will to gain the technological edge in this constantly evolving form of covert warfare' (Wilkinson, p. 10).
[12] Mokyr (2002), p. 162.

Appendix A: The Diffusion of Weapons – A History

The Place of Weapons in Classical Commentary

Military tacticians and strategists have overwhelmingly been concerned with how to win battles and wars.[13] One should not expect, then, for the bulk of their writings to revolve around the origins of war-fighting implements, but rather to elucidate the manner by which the means at hand are to be used to achieve victory. Nevertheless, the great military thinkers thought broadly and deeply about many constituents of the military equation and their thoughts sometimes turned to technological development and new weaponry. Where these occur, such ruminations are relevant, both intrinsically and because the opinions of the luminaries among military theorists often exerted a strong influence on the behaviour and attitudes of those members of military and political staffs down the line of history who were entrusted to actually make decisions concerning new weapons.

Among the ancient strategists, there is very little discussion of weapons development or military technology as such. Sun Tzu hardly mentions weapons at all, except for a cursory mention of crossbows, bows, spears and chariots[14] and certainly does not provide criteria for evaluating or using new technologies. Kautilya refers but briefly to traditional weapons (in Book 9, Chapter 2 of the *Arthashastra*) and then only to advise on their tactical use. He does, however, expound at some length on the production and use of a variety of toxic smokes and poisons by which one can overcome an intransigent foe, thus making his treatise one of the first manuals of chemical and biological warfare.[15] Yet, even the latter discussion does not conceive of weapons technology as such. In fact, it was not until the seventeenth century, with the publication in Japan of Miyamoto Musashi's *Book of Five Rings*, that a discussion of weapons featured prominently in a text devoted primarily to martial strategy.[16] Musashi expends much of

[13] This was true at least until the advent of nuclear weapons, when it can be argued that theorists began to seriously consider how to refrain from actually fighting large wars, let alone winning them – see a similar discussion in Buzan, p. 31.
[14] Sun Tzu, *On the Art of War – Special Edition*, translated by Lionel Giles, edited by James H. Ford (El Paso Norte Press, 2005), II.14 and V.15.
[15] Kautilya, *Arthashastra,* Book XIV 'Secret Means'. Accessed from http://www.bharatadesam.com/literature/kautilya_arthashastra/arthashastra.php, on 8 April 2009.
[16] Of course, several well-known Greek and Roman observers (most prominent among them Thucydides) discussed the use of weapons, but most of these narratives were generally of a more historical than

his effort on an idiosyncratic amalgamation of swordsmanship and spiritual philosophy, but in so doing he succeeds in drawing attention to the importance of weapons and their performance. 'The Way of the Warrior', he states, 'is to master the virtue of his weapons. If a gentleman dislikes strategy he will not appreciate the benefit of weaponry'.[17] Perhaps uncharacteristic of a master swordsman, Musashi analysed and endorsed the battlefield utility of a variety of other weapons, even acknowledging that 'the gun has no equal among weapons', at least not until the point when swords cross, whence guns become in his words 'useless'.[18] He does not, however, dwell on the origins or development of these weapons, but seems to take their existence as a starting point for analysis.

The nineteenth century heralded a golden age of grand theories of military strategy. The doyen of that period's strategists was Carl von Clausewitz, who distilled his experiences in the Napoleonic Wars into his magnum opus of military theory, *On War*. In his characteristically thorough style, Clausewitz acknowledges that weapons are an important aspect of the totality of warfare in that 'Fighting has determined the nature of the weapons employed. These in turn influence the combat; thus an interaction exists between the two'[19] and even goes so far as to recognize changes in the modes of war, wherein combatants were led to 'invent appropriate devices to gain advantages in combat, and these brought about great changes in the forms of fighting'.[20] Yet he firmly minimizes the importance of these changes and in essence dismisses the entire enterprise of studying weapons development or adoption.

He does this in at least three ways. First, Clausewitz argues in a most straightforward manner that while the instruments of war (or rather their effects) are important, the origins thereof are largely irrelevant:

> The range and effectiveness of different firearms is tactically most important;

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predominantly strategic nature and relevant commentary from these sources is included in the historical survey that follows.

[17] Miyamoto Musashi, *Book of Five Rings, Book of Earth*. Accessed from http://www.miyamotomusashi.com/gorin.htm, on 8 April 2009. He goes further to state emphatically that: 'This is a truth: when you sacrifice your life, you must make fullest use of your weaponry. It is false not to do so, and to die with a weapon yet undrawn.' As part of maximizing a weapon's potential, Musashi admonishes his readers to ensure their weapons are hardy and without defect.

[18] Musashi, *Book of Five Rings, Book of Earth*.

[19] Carl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), p.127.

[20] Ibid.

> but their construction, though it governs their performance, is irrelevant. The conduct of war has nothing to do with making guns and powder out of coal, sulphur, saltpetre, copper and tin; its given quantities are weapons that are ready for use and their effectiveness.[21]

Second, Clausewitz attempts to create a conceptual separation between the invention or procurement of arms and the actual fighting or conduct of war, stating that the former is distinguished from the latter by an absence of the element of danger, and asserting that the idiosyncratic nature of weapons development means that analysing the two together would obviate a strategist's ability to derive general principles about war. The implication, therefore, is that the strategist must concern himself only with 'the art of using the given means in combat'.[22] Lastly, Clausewitz contends that the only true advantage in war lies with the innate abilities of the general, as the brisk and mutual emulation of weapons capabilities by antagonists makes an analysis of the details of their development or adoption moot. In his opinion, 'what it usually comes down to is that one side invents improvements and first puts them to use, and the other side promptly copies them'.[23]

This laconic disregard for technology becomes more understandable in context. Clausewitz was something of a fervent acolyte of the Napoleonic way of war and the majority of the military innovations of that period, such as the *levee en masse*, were based on political rather than technological eruptions.[24] For Clausewitz, the morale of men and the genius of leaders reigned supreme on the battlefield. It was only later, in the post-Napoleonic period of rapid European industrialization, that the burgeoning impact on warfare of technological progress became unmistakable. One wonders whether the great man's dismissal of any discussion surrounding the adoption of new weapons and technologies would have been quite so peremptory had he put pen to paper only in the latter half of the nineteenth century.

Clausewitz's near-contemporary and putative intellectual nemesis, the Baron Antoine-Henri Jomini, appears to pay greater attention to technological developments in weapons and allows that these can bestow dramatic advantage in war, especially in terms of tactics and organization. In the *Art of War* (1838), Jomini lists examples of the

[21] Clausewitz, p.144.
[22] Clausewitz, p.127.
[23] Clausewitz, p.282.
[24] Buzan, p. 32.

increasing destructiveness of weapons, and even advocates for governments to 'combine in a congress to proscribe these inventions of destruction'.[25] Yet, although not quite as vociferously as Clausewitz, Jomini similarly does not see new inventions as having much of an impact on the strategic aspects of warfare,[26] allowing at most that 'the superiority of armament may increase the chances of success in war: it does not, of itself, gain battles, but is a great element of success'.[27]

In *Battle Studies* (1880), Ardant du Picq admits to tremendous changes in battle since ancient times as a result of technological advances, especially in the realm of increasing firepower, but seems to find a reliance on the material aspects of war to be a touch distasteful. So, while he discusses the newest weapons of his time, including rifled gun barrels and expanding cartridges, and even provides a detailed history of the progressive introduction of firearms into the infantry,[28] he still asserts the primacy of morale over machine and the superiority of élan over equipment – with devastating results for his followers, who would three decades hence occupy the trenches of the Somme.

A similar attitude prevailed at this time in the sphere of naval strategy. Both Alfred Thayer Mahan and later Julian Corbett noted improvements in weapons technology and their potential consequences for tactics but then seemed to fall back on arguments referencing general (that is, atechnological) principles of history and warfare that transcend the technological advances of the day.[29] This sentiment is pithily summed up by Mahan's dictum that 'men don't change'.[30]

It was left to Ivan Bloch in the waning years of the nineteenth century to delve deeply into the effects of increased firepower and to conclude that increases in defensive firepower would lead to long, painful wars of attrition.[31] Yet Bloch was not destined to

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[25] Baron Antoine Henri de Jomini, *The Art of War* (London: Greenhill Books, 1992 [1838]), p. 48.
[26] Ibid.
[27] Jomini, p. 47. To be fair, Jomini, like Clausewitz, was also writing based on a technological milieu that had remained mostly static for a hundred years, before major innovations of the 19th century (such as the telegraph and the minie ball–percussion cap combination) had made their mark.
[28] Ardant du Picq, *Battle Studies*, translated by John N. Greely and Robert C. Cotton (Charleston, SC: Bibliobazaar, 2006), p. 205.
[29] Alfred T. Mahan, *The Influence of Sea Power Upon History, 1660-1783* (Mineola, NY: Dover Publications, 1987); Julian S. Corbett, *Some Principles of Maritime Strategy* (Mineola, NY: Dover Publications, Dover Edition, 2004).
[30] Mahan, p.506.
[31] *La Guerre Future*, popularized in translation as Ivan Bloch, *Is War Now Impossible?: Being an Abridgement of the War of the Future in Its Technical, Economic and Politics Relations* (Farnham: Ashgate Publishing, 1991[1898]). Interestingly, two decades earlier, Friedrich Engels had written in his

have his sought-for influence on the militaries of pre-World War I Europe, who largely ignored his dire predictions that new weaponry had inescapably altered the character of war. Nevertheless, by the turn of the twentieth century, respected military strategists were far more accepting (if not quite unequivocally or happily) of the significance of advances in weaponry on the outcome of major conflicts. So it was, that although Ferdinand Foch, in his *Principles of War*, could claim that material factors were still far from being everything in modern war,[32] after analysing the advantages bestowed by superior weapons in the Franco-Prussian War, he acquiesced that 'Moral superiority, resulting from numbers, formations, etc., is no longer sufficient today with modern weapons: their effects are too demoralizing'.[33] Yet, even Foch seemed to ignore the process of weapons development or adoption and merely dealt with weapons as a prespecified input into the wartime environment.

By the decade before the Second World War, however, the pendulum seemed to have swung in the opposite direction. A host of military practitioner-scholars, coloured by their experiences in the First World War, began to fixate on the role of technology in war, in some cases elevating novel weapons to the determining factor in the outcome of contemporary warfare. While Giulio Douhet and Billy Mitchell trumpeted air power[34] and Heinz Guderian[35] and Basil Liddell Hart[36] propounded new forms of mechanized warfare, chief among the military disciples of technology during this period was surely J.F.C. 'Boney' Fuller. Fuller enthusiastically embraced the notion that weapons and their attendant technology constituted the key to military success, famously intoning that 'Tools, or weapons, if only the right ones can be discovered, form 99 per cent of victory....Strategy, command, leadership, courage, discipline, supply, organization and all the moral and physical paraphernalia of war are nothing to a high superiority of weapons—at most they go to form the one per cent, which makes the whole

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book commonly known as *Anti-Dühring* that victory in war owed more to industrial might than the general's genius (Friedrich Engels, *Herr Eugen Dührings Umwälzung der Wissenschaft* (Berlin: Dietz Verl., 1958 [1878]), referred to in Van Creveld, p.322).

32 Ferdinand Foch, *Principles of War*, translated by J. de Morinni (New York: The H. K. Fly Company, 1918), p. 8.

33 Foch, pp. 370-371.

34 William Mitchell, *The Development and Possibilities of Modern Air Power – Economic and Military* (Mineola, NY: Dover Publications, 2006), p. 119; Giulio Douhet, *Command of the Air (USAF Warrior Studies)* (Office of Air Force History, United States Government Printing Office, 1983).

35 Heinz Guderian, *Achtung—Panzer!* (London: Arms & Armor Press, 1995).

36 B.H. Liddell Hart, *Strategy*, Second Revised Edition (New York: Meridian 1991 [1929]).

possible'.[37] The transition to an almost total focus on technology reached its zenith in the work of Herman Kahn, who, in his *On Thermonuclear War*[38] (with its less than oblique nod to Clausewitz) reformulated military strategy in terms of a single, overarching technology – nuclear weapons. Kahn relegated other factors such as morale and training to the background and in fact posited no less than six future world wars, each based on more advanced technologies for conducting nuclear warfare.

The Historical Experience of Weapons Diffusion and Adoption

Primitive Weapons

We know very little detail about the origins and spread of the earliest weapons – for periods before the detailed writings of ancient Sumer, historians have to infer the development of weapons from archaeological scraps,[39] ambiguous cave drawings and the war-making implements of isolated groups of Stone Age peoples encountered in modern times. Nonetheless, a plausible story of the development of the most primitive, pre-metallurgical weapons can be constructed as follows. Early man evolved to become cognizant of the elementary physics of the world around him, which allowed him to manipulate his environment so as to transcend the limits of his biological frame. He did this using tools he selected or fashioned from materials at hand. Most of his initial tools were multi-purpose, used for hunting, gathering or making more tools. And, of course, a shaped rock or rough-hewn tree branch would come in useful for settling challenges from or against other members of his own species. In consequence, as tools began to specialize for specific tasks, it was only natural that some of them would be crafted with the specific end of enhancing one's odds in any physical altercation with another human being. So it was, then, that the first weapons acted mainly to extend the reach and power of the human body. The heavy club[40] exerted leverage over a distance and the wooden

[37] From a memorandum that Fuller wrote in 1919. Cited in J. F. C. Fuller. *Armament and History: The Influence of Armament on History from the Dawn of Classical Warfare to the End of the Second World War* (New York: De Capo Press, 1998 [1945]), p.30.
[38] Herman Kahn, *On Thermonuclear War* (Princeton, NJ: Princeton University Press, 1960).
[39] Many of the earliest weapons were made of wood, which rarely preserves well, thus leaving an incomplete record of fortuitously preserved wood, partial wooden remnants of weapons and the hardier bits of early weaponry, such as those crafted of bone and stone.
[40] Some of the earliest evidence for these weapons comes from South African rock paintings dated circa 6,000 BCE that purportedly show the use of clubs (The Diagram Group, *Weapons* (New York: St. Martin's Press, 1990), p.14). It is possible, however, that forms of the club existed much earlier.

spear[41] was an extension of the arm that concentrated force in its tip and therefore provided the ability to penetrate flesh. Such specialization into means of combat was sometimes obvious. A wooden axe, for example, is of little use for cutting timber, but can still do a good job of splitting skin and muscle. Bone and stone, however, proved to be more robust than wood and were promptly added to the mix from at least 200,000 years ago in the form of spear-points, daggers, picks, war-axes and other variations on the basic theme.[42] Although the majority of early weapons were only suitable for close combat, others were developed to cover greater distances, including the *bolas*, the sling and the atlatl, the latter being traced as far back as the Upper Paleolithic.[43] While many of these early weapons were superseded by the superior metal varieties, some civilizations that were at once very warlike and sophisticated never made the transition beyond wood and stone weapons, the Aztec and Maori being two prominent examples.

One of the most long-lived weapons in history also made its appearance in prehistoric times. The bow, most likely the first true machine in that it stored muscular energy and released it as mechanical energy, made its debut as far back as 10,000 years ago,[44] if not earlier, and quickly established itself as the consummate hunting tool, as well as an enduring projectile weapon.

Considering the rather arid baseline, it can be argued that the earliest forms of almost all these weapons can be (and perhaps were) regarded as innovations. In many cases, initial awareness of their value probably came from trial with similar tools used for hunting, with the combat application quickly becoming evident. After all, anything that will bring down a wild boar is likely to fare at least as well against a physically inferior human opponent. There is still debate over the extent to which these early weapons diffused from a single locus or were developed independently in multiple locations,[45]

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[41] Wooden spears were probably used for hunting at least 400,000 years ago and the fact that chimpanzees have been observed making simple wooden spears implies that early humans may have first begun using them as far back as 5 million years ago (Jill D. Pruetz1 and Paco Bertolani, 'Savanna Chimpanzees, *Pan troglodytes verus*, Hunt with Tools', *Current Biology* (March 6, 2007)).

[42] Although occurring far later in history, the embedding by the indigenous peoples of Kiribati of shark teeth into their wooden clubs to create a form of proto-sword is an illustration of the diverse ways in which bone has been combined with wood.

[43] James Edward McClellan and Harold Dorn, *Science and Technology in World History: An Introduction*, 2nd Edition (Baltimore: Johns Hopkins University Press, 2006), p.11.

[44] Paleolithic carvings in Castellon, Spain seem to indicate bows being used in combat, in addition to hunting (The Diagram Group, p.96).

[45] In some cases the diffusion process is straightforward. For instance, the wooden spears and clubs of the denizens of Polynesia accompanied them as they settled island after island, as far as New Zealand, where the Maori supplemented the *wahaika* and *patu* (wooden clubs) with the *mere* (a club made from jade). In

but the relatively rapid (by prehistoric timescales) ubiquity of especially the club, spear and bow across multiple cultures demonstrated that early man quickly became aware of the advantages these specialized tools presented in relation to both hunting and conflict with other groups or individuals. Awareness no doubt either led to fast emulation or likely decimation, making the decision one of 'adopt or die.'

Decisions on whether to adopt new weapons in primitive societies were therefore driven by a rational desire for survival first and foremost. However, even at these early stages, simple expediency was not the only factor. Keegan elegantly details the limitations placed on the choice and use of weapons by the Yanomamö, Maring and Aztec peoples based on custom and religion, which led to highly ritualized forms of combat.[46] For example, Aztec weapons were designed in most cases to wound but not kill, because the primary objective of combat had become the securing of prisoners for later human sacrifice.[47]

It is a matter of debate whether one can properly speak of strategy with respect to primitive warfare,[48] but at the tactical level Hugh Turney-High notes two constraints that structured the choice and development of the earliest weapons. He first admonishes scholars for paying insufficient attention to the fact that it is not only the defender in an engagement that experiences fear; the attacker must exercise prudence in order to avoid defensive injuries and this may condition his choice of weapon. In other words the attacker could favour those weapons that can get the job done with minimum exposure to himself from any defensive measures his opponent might employ.[49] The second tactical constraint is the nature of the physical environment and in this regard Turney-High offers for comparison the terrain of east and west Africa. In the tall grasslands of the former, the bow was of little use and so spear and shield tended to predominate, while the tropical forests of the latter were not well suited for shock weapons and so the bow became the weapon of choice.[50] Keegan surmises that the rise of the bow itself may have been spurred by the greater distances available for prey to travel as the last Ice Age retreated, which may have necessitated longer range weapons capable of securing more

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other instances, for example among the early inhabitants of Western Europe, the process of diffusion was not always so clear.

[46] Keegan, pp. 95-114.

[47] Keegan, p. 114.

[48] Gray, pp. 94-95.

[49] Turney-High, pp. 6-7.

[50] Ibid, p. 19.

dispersed meals.[51]

In addition to the constraints of custom and terrain, there was also, of course, the limitation in the days before systems of trade that early weapons could only diffuse to areas where the materials for their construction were relatively easily available. These features no doubt introduced a healthy dose of conservatism in approaching new weapons, but the exigencies of continued survival in a world 'red in tooth and claw', introduced powerful incentives to innovate when it was clearly necessary. For example, the relatively rapid mass adoption and production by the inhabitants of Easter Island of the *mata'a*, an obsidian spearhead more deadly than its predecessors, accompanied a period of increasing social instability.[52]

In terms of their performance, even though many of the earliest weapons were eventually eclipsed by other weapons for large-scale military use, several of them proved so reliable and effective on the battlefield that they perpetuated into the Bronze and Iron Ages and even into modern times. For instance, the Bayeux tapestry (circa late eleventh century) depicts William the Conqueror brandishing a club,[53] and of course bows were only supplanted by firearms in the sixteenth century and spears (in the form of pikes) even later. However, the earliest weapons were not capable of dispatching multiple opponents with a single action, a development that would have to wait for a later age.

The Age of Metal

The search for a material stronger than wood but more durable than brittle stone must have led our ancestors to look closely at copper, deposits of which were widespread and fairly easily obtainable.[54] The problem with copper is that it is too soft for use as an effective weapon. The discovery in Mesopotamia around 3500-3000 BCE[55] that combining it in an alloy with tin yielded a robust metal (bronze) suitable for a variety of edged and pointed weapons therefore represented one of the earliest major innovations in the means of combat. The so-called Bronze Age heralded the development of a broad

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[51] Keegan, p. 119.
[52] Keegan, pp. 26-27.
[53] Toffler and Toffler, p. 43
[54] Volkman, p. 16.
[55] McNeill gives the date as around 3500 BCE (McNeill, p. 9), but most commentators have the Bronze Age beginning in the Near East around 3300 BCE and in other areas later.

range of weaponry, including metal maces, scimitars, spears and arrowheads, but the application of metallurgy to warfare was not without its complications. Chief of these was the fact that, while copper was plentiful, tin was not and the life-blood of the new military industry had to be imported from outside Mesopotamia, making the users and manufacturers of these weapons dependent on trade and transport.[56] Unavailability of materials may thus have been one reason why Egyptian warriors at the start of the Middle Kingdom (approx. 2000 BCE) were still using clubs and stone-tipped spears,[57] even though bronze weapons were widely utilized elsewhere. Another explanation for their failure to adopt this important innovation until much later is that they chose not to, perhaps for ritualistic or other yet-to-be-determined reasons.[58] Bronze did not only enhance the penetrating and cutting actions of combat, but also proved to be a workable material for the defence, enabling the construction of bronze armour to protect against these amplified offensive capabilities. Moreover, the coming of bronze was not just a boon for weaponry, but introduced a variety of other tools, thus creating what may have been the first, but would certainly not be the last, instance in history where an innovation had simultaneous military and civilian applications, giving rise to a political and economic dynamic both between and around them.

Yet perhaps the most significant contribution during this period to the military arts was an innovation that for the first time made mobility a major factor in warfare – the rise of the war chariot in approximately 1800 BCE.[59] The development of light (less than 46 kilograms), strong vehicles mounted on a fixed axle to which wheels that used a hub and spoke design were attached, was a leap in technological complexity.[60] The war chariot originated amongst nomads of the steppes of Central Asia, most likely as a superior means of hunting,[61] and was based on the lumbering ox-carts that had previously been used for transportation.[62] When married with the horse and an equally potent innovation, the shorter yet powerful and accurate composite bow,[63] the war

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[56] Keegan, p. 134; McNeill, p. 1.
[57] Kemp, p. 269.
[58] Keegan, p. 131.
[59] Van Creveld, pp. 12-13.
[60] Volkman, p. 14; McNeill, p. 10.
[61] John N. Wilford, 'Remaking the Wheel: Evolution of the Chariot', *New York Times* (22 February 1994), p. C1; Keegan, p. 165.
[62] Volkman, p. 14.
[63] The power of the simple bow was enhanced by layers of bone and sinew to form the composite bow (Dunnigan, p. 8) which is thought to have originated with the steppe peoples and evolved in lockstep with the chariot (Keegan, pp. 162-163). The shorter composite bow, with its enhanced flexibility, was capable

chariot constituted a complete weapons system that swept all before it. The chariot vastly increased the speed and mobility of combatants and, initially at least, completely overwhelmed even bronze-armed and -armoured infantry. The steppe nomads, with their ample supplies of horses, descended with their chariots upon the lands of the Near East and in short order subjugated the existing civilizations of Mesopotamia, Egypt, India and China.[64]

The conquered peoples did not sit idly by – they had been taught a harsh lesson in the effectiveness of this new weapons platform and set about adopting the weapon of their conquerors as rapidly as possible. Although it took several centuries for the adopters to refine chariots to the breath-taking level of perfection depicted in films such as *Ben Hur*, the indigenous populations of the Near East wasted no time in casting off the yoke of the original charioteers.

One outcome of the adoption of chariots was its effect on the military itself. Since chariot warfare required expensive materials, well-trained and well-fed horses, and highly-skilled workmanship, it could not be a plebeian instrument, but a weapon whose use was restricted to a specific class of warrior, one who came to occupy a central position in society.[65] Some scholars contend that the chariot, owing to the arms races it initiated and the huge logistical burden it imposed, was thus responsible for the creation of the 'warmaking state', including the first true army capable of campaigning.[66] So, in addition to providing one of the earliest clear examples of the rapid diffusion of a militarily successful technology, the Bronze Age chariot also demonstrates the effect that new weapons can have on the institutions that adopt them.

The dominance of the chariots was cut short with the discovery of methods for smelting

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of firing with equal if not greater power than a much longer simple bow, thus making it ideal for use in the confines of a moving chariot.

[64] McNeill points out that in Southern Europe chariots did not have quite the same impact, with warriors tending to dismount for combat and use chariots mainly as a means of transporting troops, but does not offer a reason for this seemingly anomalous behaviour (McNeill, p. 11). Perhaps McNeill is referring to the later period after the 11th century BCE, when chariots everywhere became less of a battlefield weapon and more a source of ceremony and sport. Another possibility is the unsuitability of the terrain in Southern Europe for effective use of the chariot as a weapon on the battlefield. In the British Isles, the Celts did use war chariots in the traditional manner as a weapons platform, but probably only from the 6th century BCE.

[65] See Van Creveld (p. 13) for a discussion of how change manifested itself in some polities in the rise of an aristocracy and in others cemented the control of the central state. Also, see McNeill, p.12.

[66] Keegan, p. 169; Wilford, C1; and Robert Drews, *The End of the Bronze Age: Changes in Warfare and the Catastrophe ca. 1200 B.C.* (Princeton: Princeton University Press, 1993), p. 112.

iron, which although more difficult to make (by requiring hotter temperatures), carries the advantages of being much more abundant and (eventually) providing for a more durable weapon edge than bronze. The technology of iron-smelting first arose sometime between 2000 and 1400 BCE in what is now Anatolia,[67] and was exploited by the Hittites (or, more correctly, the Hattusa people). Interestingly, unlike the case of the bronze chariot, this new technology did not diffuse immediately, but remained the sole province of its discoverers for at least two hundred years, until around 1200 BCE. Two reasons have been advanced for this delay in diffusion: first, that the Hittites were able to maintain a monopoly on the working of iron which was relinquished only when they were overcome and their ironsmiths subsequently dispersed, taking their skills to new areas and, second, that the technology itself only matured at this time, with the development of the technique of hammering the metal while hot and quenching in water, which was for the first time able to give iron an edge that was harder, longer-lasting and thus superior to bronze.[68] Either of these developments, or both in concert, might therefore have acted as a catalyst or 'tipping point', allowing the technology to be widely adopted for weapons use – a paradigm that may have relevance for the subject of terrorist adoption of emerging technologies.

Iron bestowed both tactical and organizational advantages, both of these stemming from its greater availability and thus lower cost. For one thing, the use of iron armour and the extravagantly-sized weapons that the relatively cheap material permitted, for the first time allowed foot soldiers to stand up to chariots. For another, the fact that a far larger number of men at arms could be equipped with iron weapons diluted the political power of the elite chariot-riders, leading to a 'radical democratization of war'[69] in which iron-armed masses overthrew the chariot-dominated kingdoms. It was the Assyrians who rode a wave of iron to conquer almost the entire Near East. Moreover, the Assyrians were far from languid adopters of this new technology (a label that might apply to the Egyptians of that age); according to Volkman, they established a significant military research and development program at their capital Nineveh where they paid technicians to develop new war-making implements, such as a conical helmet that could deflect

[67] Volkman, p. 18; Van Creveld, p. 13; Recent archeological finds have dated iron remnants found in Turkey to 2100-1950 B.C. (Nobuyuki Watanabe, 'Excavation in Turkey set to rewrite history of Iron Age', Asahi Shimbun (27 March 2009)).
[68] Keegan, pp. 238-239.
[69] McNeill, p. 12.

arrows.[70]

What is remarkable about iron is that, in the form of swords, spears and pikes, it persisted as the dominant basic weapons material for almost another two and a half millennia. Occasionally in the history of warfare, though, the benefits of iron were taken too far and the temptation to create ever larger weapons with it actually reduced military effectiveness. In these cases it could be a decision to employ smaller weapons that represented a beneficial innovation. For example, in 19th century Africa, one of the most astute and advantageous innovations of the hugely successful Zulu king Shaka was to reduce the length of the spear to create a shorter stabbing weapon – an instructive lesson that, when it comes to weapons, bigger is not always better.

Near the end of the seventh century BCE, a new military force emerged – the cavalry – as Scythian nomads from the steppes once again invaded the lands of the Near East.[71] Through selective breeding, horses had been developed that were strong enough to bear an armed man on their backs, thus providing a mobility advantage over chariots, since horses could manoeuvre over more varied terrain. In 612 BCE, the Assyrian Empire crumbled before these horse people.

Even during the age of Assyrian dominance, the existence of basic fortifications (usually in the form of high walls) around many cities prompted the development of siege engines, which protected besiegers as they assaulted the defenders on the walls.[72] However, from around 400 BCE, new mechanical engines began to appear, first in the form of overgrown crossbow-like contraptions and then torsion-based machines, such as the *ballista*, the *onager* and, later, the *katapoltos* (catapult). The primary innovation of these mechanisms was their ability to accumulate and store the energy of one or many men for a significant period, before releasing the combined energy to thrust a projectile

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[70] Volkman, pp. 20-21.
[71] Keegan, pp. 177-178. Keegan notes (p.177) that the Assyrians had bred a sufficiently strong horse by the eighth century BCE, but they were apparently not as proficient with these animals as the steppe nomads.
[72] Thucydides ably demonstrates the difficulties involved in attempting to overcome the dedicated defence of a city in a *History of the Peloponnesian War* (sections 2.75, 2.76 and 4.100), with both the besieged and the besieger trying to undermine (sometimes literally) each other's constructions (see Thucydides, *History of the Peloponnesian War*, Thomas Hobbes tr. (London: Bohn, 1843), accessed from the Perseus Digital Library, Tufts University, at www.perseus.tufts.edu.

with great power and speed,[73] independent of the physical or moral condition of the operators.[74] This represented the rise of a new and important technical role in the military beyond the mere craftsman – the engineer who used his understanding of mathematical and physical principles to design and operate these imposing weapons. These technical principles, which were proving so useful in war, were made possible by significant leaps both in man's understanding of the natural world and in humanity's attitude towards discovering these secrets, advances driven by the Greek philosophers we know so well, men such as Plato, Aristotle and Socrates. Moreover, for the first time, it was the scientific, rather than the purely physical, prowess of a man that might make him valuable in combat.

It was arguably the Greeks' orientation towards technology that accounted for a large part of their military success. They encouraged the free flow of scientific ideas[75] among engineers and travelled extensively with their designs, which facilitated their diffusion and improvement. Also, engineers generally believed that science could be applied in service to the state and, as had been the case with the Assyrians, they were encouraged (often by the promise of huge reward) by many of the rulers of the Greek city-states. For example, the catapult was invented during a substantial program of weapons development presided over by Dionysus, the ruler of Syracuse, 'since the ablest skilled workmen had been gathered from everywhere into one place. The high wages, as well as the numerous prizes offered the workmen who were judged to be the best, stimulated their zeal'.[76] This tradition continued under Philip of Macedon and his son Alexander the Great,[77] the latter bringing these mechanical machines into the field for use as artillery. Most scholars accept that (contrary to Plutarch) even Archimedes applied his prodigious acumen to weapons development,[78] organizing a spirited defence of Syracuse against the Romans using siege engines,[79] and perhaps even inventing a steam-powered catapult.

[73] Soedel and Foley describe that with the best torsion-based machines, it was possible to project a stone weighing as much as 78 kilograms (Werner Soedel and Vernard Foley, 'Ancient Catapults', *Scientific American* (1979), pp. 150–60).
[74] Van Creveld, p. 32.
[75] Volkman, p. 25.
[76] Diodorus Sicilius, *Library of History Vol. VI*, translated by C. H. Oldfather (Cambridge, MA: Harvard University Press, 1954), p. 131 [Book XIV, Chapter 42].
[77] Soedel and Foley, pp. 150-160.
[78] Ibid.
[79] Steele and Dorland, p. 2. Unfortunately, although Archimedes' defensive siegecraft was effective against repeated Roman assaults, the city fell to the Romans in 212 BCE, when they entered through an unguarded gate during a Syracusan religious festival.

While there were occasional advantages enjoyed by one party or another, the use of siege engines spread rapidly, at least around the Mediterranean and beyond. For example, as late as the seventh century CE, Muhammad enthusiastically embraced the use of siege engines (trebuchets) in his famously successful siege of the city of Ta`if.[80] However, after the spurt of diffusion of the original Greek technology, further innovation with respect to siege engines slowed down. For example, although an ingenious repeating catapult was invented, which could fire multiple bolts in rapid succession, military commanders did not put it to much use, ostensibly fearing that it would waste ammunition.[81] Historians also seem to concur that the Romans, despite using the Greek *ballistae* and catapults extensively, did not try to improve on them,[82] and indeed did not feel it necessary to innovate much beyond Greek technology in general. Instead, they relied on reverse engineering captured technology when absolutely necessary.[83] Indeed, the famous Roman civil servant, Sextus Julius Frontinus, declared in the first century CE that he would '[Lay] aside also all considerations of works and engines of war, the invention of which has long since reached its limit, and for the improvement of which I see no further hope in the applied arts'.[84]

While siege engines can be argued to have shifted the advantage somewhat to the offence in the struggle between besieger and besieged,[85] they never reached the level where they could breach well-constructed fortifications. They were, however, excellent for use as terror weapons, harrying defenders, hurling missiles in high arcs to hit targets in the interior of a fortified city, or even being used as a more exotic delivery system, to cast everything from incendiaries, to live snakes and dead horses, into a besieged

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[80] George F. Nafziger and Mark Walton. *Islam at War: A History* (Praeger Publishers, 2003), p. 13
[81] Soedel and Foley, pp. 150-160.
[82] Volkman, p. 34; Mokyr (1990), p. 21.
[83] Volkman (p. 35) describes how when the Romans encountered superior Carthaginian warships in 260 BCE they did not try and improve their own ships, but instead captured a Carthaginian warship, discovered how it was built and made hundreds of copies in order to defeat the Carthaginian navy. Rice describes at length a case study of how the design and development of immense warships spread from Macedonia, to Epirus, to Carthage, to Rome in a period of thirty years, as an early instance of repeated diffusion and technology transfer (Rob S. Rice, 'The Peregrinations of the Queen: Technology Transfer in the Hellenistic World' *1996 APA Convention Session on Naval History*, New York Hilton, Regent Parlor).
[84] Frontinus, *Strategems*, translated by Charles E. Bennett (Cambridge, MS: Harvard University Press, 1925), p. 205.
[85] Soedel and Foley, pp. 150-160.

town.[86] These tactical attributes undoubtedly served to encourage (if not, on occasion, to precipitate) a speedier capitulation by the besieged forces.

This brings us to a brief reference to more exotic weaponry invented by the Greeks, their successors and other military powers of the time. These included working flamethrowers, increasingly complex oared fighting ships (from triremes to quadriremes and possibly quinqueremes),[87] and innovative ship-borne ramming and striking equipment.[88]

The early years of civilization thus contained several important innovations, most (but not all) of which were adopted widely as soon as they were shown to provide military advantage. At the same time, one should not become mesmerized by the ingeniousness of these weapons and forget the continuing relevance throughout this period of training and morale (as epitomized by the epic story of the Battle of Thermopylae), as well as the often decisive role played by great leadership, embodied in commanders such as Alexander and Julius Caesar.

Medieval Warfare

The first major innovation of the medieval period was the widespread adoption of the stirrup, high saddle and the horseshoe,[89] which presaged a new form of warfare – that of the armoured knight on horseback. Around 500 CE, the stirrup appeared; although its origins (Indian or Chinese) are cloudy, we do know that it diffused rapidly from the steppe peoples to Europe.[90] Some scholars regard this as a watershed innovation in that it enabled the warrior to firmly implant himself on his mount, thus enabling the use of heavy sword and lance, in addition to the bow, while seated on horseback.[91] Others

[86] Van Creveld, p. 33.
[87] Van Creveld asserts (p. 69) that these increases in the size and complexity of fighting ships reached a point where these ships became militarily useless, suggesting that competition to be bigger sometimes led to non-rational (in a tactical sense) weapons development.
[88] Volkman (p. 20) points to a brace design for a ram as a key scientific advance in this regard, and Yang Hung describes the use of a 'striker' on Chinese ships from around 567 CE (John W. Killigrew 'Reviewed work: Chung-kuo Ku-ping-ch'i t'ao-lun [A Discussion of Ancient Chinese Military Equipment] by Yang Hung' *Military Affairs*, 46:1 (February 1982), p. 47).
[89] The origin of the horseshoe has not been conclusively determined – Van Creveld, p. 18.
[90] Initially, stirrups consisted of cloth loops, but eventually these were replaced by iron and were attached by the eighth century (Keegan, p. 285) to a solid seat.
[91] Lynn White, for example, perceived a direct connection between the introduction of the stirrup and the rise of feudalism (Lynn White, *Medieval Technology and Social Change* (Oxford: Oxford University Press, 1962), p.28). According to this line of thought, the new, expensive armour and armaments which

downplay its significance by claiming almost equal proficiency for highly skilled but stirrupless horsemen,[92] such as the cataphracts of Eastern Europe and Asia. The debate has yet to be decided conclusively one way or another, but demonstrates that the military advantages of an innovation may not always be quite as clear or easy to evaluate as one might expect. Nonetheless, by the ninth century, the dominant force on the European battlefield became the heavily armed and armoured knight. It was not, however, a complete dominance by any means – as Van Creveld points out, the expense and availability of suitable horses meant that only a tiny proportion of fighting forces could be so equipped, and even the vaunted knight was not much help for many military functions, including holding captured ground and laying siege,[93] thus requiring a continued role for infantry and siegecraft. Nor did the knight necessarily prevail against non-European contemporaries, such as the Muslims (*vide* the Crusades) or the mounted steppe warriors of the time.

Once he had adopted his basic set of equipment, however, the armoured knight on horseback is often caricatured as among the most elitist and conservative of creatures, at least with respect to weapons innovation. John France writes of this age that '[t]here was no forum in which to develop weapons…for war already had its elite, who felt no need to give way to any new forces…there was no marriage of thought and technology, so that advance remained piecemeal and by individual experiment. In these circumstances, new ideas would have been diffused only slowly and unevenly'.[94] In fact, many of the most important innovations of the medieval period would arise from those wishing to challenge the supremacy of the knight, rather than from the ranks of the noble heavy cavalry itself.[95]

Sometime during the twelfth century CE in Wales, the locals began using large simple bows made of Mediterranean yew, cut and cured so that they carried the power to launch arrows that rivalled if not exceeded that of the best composite bows.[96] The

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the stirrup and saddle enabled could only be sustained by an elite class of warrior (the knights), and it was to support this class of warrior that the entire feudal economy developed.

[92] Dunnigan, p. 5.

[93] Van Creveld, p. 19.

[94] John France, *Western Warfare in the Age of the Crusades, 1000-1300* (Ithaca, NY: Cornell University Press, 1999), pp. 49-50.

[95] One exception to this was the replacement of chainmail by plate armour, the latter becoming predominant among the heavy cavalry of Europe by the 14th century.

[96] Dunnigan aptly describes the longbow as an ' "organic" composite bow' (p. 8) since, although it used a single piece of yew, this piece was selected to ensure that the sapwood (which was flexible to resist

longbow, as it came to be called, might never have transcended the ranks of highly effective local hunting weapon were its tremendous military potential not recognized by a person with the authority to transform it into a revolutionary weapon of war.[97] It was Edward I of England who, during a campaign to quash a Welsh rebellion in the late thirteenth century, first encountered the longbow and saw the opportunity to organize groups of archers using this weapon to deliver a devastating concentration of fire. When used with a (for the time) technologically advanced, longer arrow (over three foot) capped with a conical, squared 'bodkin' arrowhead, the longbow was capable of piercing much of the armour of the day over substantial ranges.[98] The longbow made its splash on history at Crécy in 1346 and even dominated the field at Agincourt in 1415, when ranks of English commoners wielding longbows were instrumental in securing victory for the English against much larger French forces. These and other battles during the Hundred Years' War arguably represented the beginning of the end to the battlefield (and some would argue also social and political) supremacy of the mounted knight by introducing a form of concentrated firepower.[99] The longbow was another example, of course, of a weapon only achieving full effectiveness when combined with optimal tactical deployment. Although the armies of Europe soon clamoured to introduce these newly decisive weapons, the primary drawback of the longbow soon became apparent – unlike most other weapons, its effective use depended on the skill of the archer and over a decade of intensive training was required to produce the required level of expertise. Archery contingents thus became much sought-after and expensive military commodities, with desired numbers of archers not always being available to field in battle.

A partial answer to this limitation lay in the crossbow, a weapon with a long provenance. The crossbow had been in use in Ancient China[100] since approximately the fifth century BCE – Sun Tzu refers to its usefulness in combat in the *Art of War* – and there is evidence of the development of similar devices in Ancient Greece shortly

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tension) lay next to the heartwood (which resisted compression), with the entire bow subjected to the applications of oils or fats to keep it supple and weather resistant (Volkman, p. 42).

97 Volkman, p. 44.

98 The longbow was more effective against chain-mail and wrought iron armour than against the most expensive steel plate armour (Strickland and Hardy, pp. 272-278).

99 Inventive tactical use of a long-standing weapon, the pike, was also shown to be effective against heavy cavalry in battles such as Laupen (1339), thus reclaiming the military utility of the infantryman.

100 For greater detail of archaeological evidence, see Mao Ying, 'Introduction of Crossbow Mechanism', *Southeast Culture*, No. 3 (1998), pp. 109–117.

thereafter.[101] The crossbow was bulkier than other bows and had a lower rate of fire, but the majority of the effort involved was couched in the expertise and materials needed for its construction – once in the hands of a soldier, the crossbow could remain cocked and loaded for extended periods before firing and thus required a minimum of training (ranging from hours to at most several months depending on the type of tactical deployment).

The crossbow was far from the perfect weapon – it was expensive to produce and maintain, requiring legions of skilled technicians, its low rate of fire made it better suited for defending fixed fortifications (where the crossbowman could duck behind cover while reloading), and it was inferior in performance in several ways to the best longbows and composite bows. It did, however, represent an early form of weapons automation[102] or 'mass' production and helped offset some of the military disadvantage if one was short of well-trained archers. Although being produced in the hundreds of thousands for use in Chinese arsenals for centuries (including such innovations as a repeating version), crossbows never became popular in Europe except for pockets in the Italian principalities.[103] After all, it was not as if the warrior class at the time, the mounted knights who dominated military matters, was overly enthusiastic about having to deal with a lot of crossbow bolts on the battlefield being fired at them by commoners, no matter how useful these weapons could be. The distaste for the crossbow among the ruling class of men-at-arms may have had something to do with a general feeling in some quarters that the crossbow was somehow immoral, leading to contested reports that Pope Innocent II in 1139 tried to impose an early form of arms control by limiting the use of crossbow to non-Christian targets.[104] In the end, it was not until the eleventh to thirteenth centuries CE that Europe developed the production capacity or tactical vision to employ crossbows to impact battlefield outcomes.[105]

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[101] Duncan Campbell refers to the discussions of both Diodorus Siculus (14.42.1) and Hero of Alexandria of crossbows, including an early hand-held version called the *gastraphetes* (Duncan Campbell, *Greek and Roman Artillery 399 BC – AD 363* (Oxford: Osprey Publishing, 2003), pp. 3-8).
[102] Dunnigan, p. 279.
[103] Dunnigan, p. 9; McNeill, pp. 67-68. The Romans, for example, chose not to employ crossbows in any quantity. Crossbows were initially utilized mainly as ship-borne weapons to repel boarders, but eventually mercenary units of crossbowmen became popular in medieval Italy.
[104] If it actually occurred, this may have been one of the earliest instances of an attempt to brand a weapon as 'beyond the pale', something that statesmen would later attempt to do with WMD.
[105] One example of the effectiveness of the crossbow is its use in keeping Muslim attackers at bay during Richard the Lionheart's march down the Levantine coast in 1191 (Matthew Bennett, 'The Crusaders' "Fighting March" Revisited', *War in History* 8:1 (2000), pp. 1-18). The exploits of the Catalan Company of crossbowmen between 1282 and 1311 also demonstrated the usefulness of the crossbow in battle.

Some scholars argue that the crossbow never seriously challenged the position of the mounted cavalry, since the knight's armour simply became more robust to deal with increases in the efficiency of the crossbow.[106] At least, that is, not until crossbows began to be made out of steel and use a windlass to draw the string in the latter fourteenth century. By this time, however, the emergence of a new, explosive projectile weapon began to claim the attention of innovators and the further development of crossbows largely ceased, although they were still used for a few more centuries. Nevertheless, the combination of the crossbow, longbow and pike are claimed by many to have heralded the end of the reign of the mounted and armoured knight in Europe.[107]

One case of innovation during the early Middle Ages bears mention, not only for its effectiveness but because its use did not spread beyond its original inventors. While the aforementioned Greek and Roman incendiaries had on occasion proven militarily helpful, the use of such weapons was perfected during this period by the Byzantines in the form of 'Greek fire', a liquid-based incendiary similar to napalm that was propelled by pumping through a nozzle and that proved especially destructive against the wooden naval vessels of the time, as its flames could not be put out with water. 'Greek fire', while not revolutionizing warfare by any means, did prove crucial in defending Constantinople against the onslaught of Arab Islamic forces in 674-678 CE[108] and again against the Ottoman Turks in 716 CE.[109] Significantly, Byzantium was long able to prevent the diffusion of the secret of 'Greek fire' (especially to the Turks) which provided it with a military advantage for hundreds of years,[110] a feat almost unequalled in the history of weaponry.

The medieval period also included several examples of societies that succeeded, at least for a time, without the latest military innovations. In the Muslim case, the astounding initial military successes of Muhammad and his followers were driven more by the fire of their young religion than any type of technology, although during the first centuries of Islamic empire, Muslim scientists adapted and developed the wisdom of the ancient

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[106] McNeill, p. 80 and Hall, p. 17.
[107] Buzan, p. 18, and Bevin Alexander, *The Future of Warfare* (New York: Norton Company, 1995), p. 66.
[108] Nafziger and Walton, p. 154.
[109] Volkman, p. 55.
[110] John Arquilla, 'Patterns of Commercial Diffusion', in Goldman and Eliason (ed.), pp. 348-371; Keegan, p. 319.

Mediterranean and East, including weapons such as siege engines. However, even during these years they produced precious few original weapons and after the Islamic theologian al-Ghazali (1058-1111) concluded that science and technology were incompatible with preservation of the faith, further scientific progress was attenuated.[111]

In the thirteenth century, the Mongol hordes swept through much of Eurasia, eliminating all opposition, primarily through the genius of Genghis Khan's organization and tactics rather than any new weapons besides their reliable ponies and composite bows. Yet the Mongols, while not innovators themselves, were canny enough to employ the weapons of their conquered foes, mostly incorporating foreign units drawn from vanquished armies into their own formidable forces.[112] Thus, in one sense the Mongols functioned as a dissemination mechanism for innovative weaponry from East to West and vice versa, rather than as a wholesale adopter of these weapons.

Van Creveld has argued that the medieval period (and even the millennium before it) did not result in any great innovations in weapons, but rather the incremental adaptation and improvement of existing weapons, such as the bow, the sword and the shield.[113] Whether one chooses to agree with so strong an assertion, it does indeed appear as if the number and type of new weapons, and the impact they had on warfare, was less than that experienced either in the preceding or succeeding periods. Diffusion of many of the innovations that did occur was usually slow, with adoption often resisted by the ruling elites, the crossbow in Europe being a prime example.[114]

The Age of Gunpowder to the Time of Napoleon

The development and diffusion of gunpowder-based weapons is a topic that has itself grown into a distinct sub-field of military history; as such, this short summary cannot

[111] In the wake of al-Ghazali's writings, the caliph ordered the burning of manuscripts and all science became tightly controlled by the ruling class thereafter – hardly a recipe for innovation in weaponry (Volkman, p. 60).
[112] The Mongols introduced the more massive Muslim siege engines into China during the campaigns of 1268-73 and are reported to have brought Chinese explosives to Hungary in 1241 (McNeill, p. 59), although the latter is strongly disputed by Keegan (p. 205).
[113] Van Creveld, pp. 20-22.
[114] McNeill contends, however, that this period contained the seeds of future military take-offs, as the advent of market conditions in China around 1000 CE led to greater efficiencies and the commercialization of weaponry that would serve as a model for future cases of diffusion in the age of gunpowder (McNeill, pp. 25-39).

hope to capture all of the literally thunderous changes that gunpowder wrought upon entire societies over a period of several centuries. So, instead of focusing on the often profound effects that the so-called Gunpowder Revolution had on a multitude of battles, institutions and socio-political systems (a subject covered quite extensively elsewhere[115]), this overview will limit itself to a brief discussion of the discernible technical innovations in the evolution of gunpowder weapons on land and sea, followed by a comparative look at the diffusion and adoption experience in five different geographic and cultural regions.

Gunpowder, a mixture of sulphur, charcoal and saltpetre, is believed to have originated in China sometime in the latter part of the tenth century CE, with the first evidence of artifices which channelled the explosive power of gunpowder to launch a projectile also appearing in China, possibly as early as the twelfth century.[116] These primitive weapons consisted of little more than vase-shaped vessels that ejected arrow-like projectiles[117] and similar devices were soon seen in Europe. The earliest guns are thought to have done more damage to eardrums than anything else, but sufficiently fascinated European rulers and craftsmen to induce a sustained effort at experimentation and development.[118] Yet, considering the difficulties – and hence expense – of procuring saltpetre during much of the fourteenth century, it is not surprising that more traditional, mechanical projectile launchers such as the trebuchet and crossbow continued to predominate in warfare well into the fifteenth century. By the beginning of the fifteenth century, however, the early projectiles had been replaced by stone spheres and the vase had elongated to form a tube, which increased the velocity attained by the projectiles. These 'bombards', as they came to be called, were commonly made of wrought iron bars welded together with hoops and often proved to be unstable, unsafe and inefficient, but nevertheless showed potential for use against fortress walls. Their great weight and consequent immobility, however, were a serious drawback.[119]

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[115] See, for example, Hall, Steel and Dorland, Parker, Lynn, Boot, McNeill and John Guilmartin, *Gunpowder and Galleys: Changing Technology and Mediterranean Warfare at Sea in the Sixteenth Century*, Revised ed. (Annapolis, MD: Naval Institute Press, 2004).
[116] A sculpture from a cave in Sichuan seems to show a vase-shaped vessel firing flames and a ball (Chase, p. 31–32; Lu, Needham, and Phan, pp. 594-605). Drawings of the earliest guns date from 1326 in both Europe (McNeill, p. 80) and China (David Harding, *Weapons: An International Encyclopedia from 5000 B.C. to 2000 A.D.* (Darby, PA: Diane Publishing Company, 1990), p. 111).
[117] Keegan, p. 319.
[118] See McNeill, p. 83 for a similar idea.
[119] The guns that were used to attack Constantinople in 1453 were so heavy that they had to be cast on the spot (McNeill, p. 87).

By the mid-fifteenth century, using a technique borrowed from bell-makers, European weaponeers discovered how to create a much stronger, smaller weapon by casting it from a single piece of bronze. Around the same time, a new method of producing granulated gunpowder (ostensibly invented by Czech alchemists[120]) called 'corning' allowed more force to be generated from a given charge. By the latter decades of the fifteenth century, French designers had combined these developments to create the first true cannon, incorporating trunnions to enable the weapon to be affixed to a two-wheeled vehicle, thus creating some field mobility,[121] and replacing the stone shot (which was shatter-prone) with smaller, denser iron balls. It was with these weapons, which closely resembled artillery used up through the mid-nineteenth century, that Charles VIII of France demolished the fortresses of the Italian kingdoms in 1494.

A little more than fifty years later, in the mid-sixteenth century, craftsmen worked out methods for casting cannon from iron, which was far cheaper and more widely available than the tin required for bronze cannon. There were precious few innovative improvements made to artillery in the seventeenth century, but the eighteenth century witnessed a host of developments, including a better understanding of the science of ballistics (worked out by the Italian Niccolò Fontana Tartaglia and English engineer Benjamin Robbins), barrels bored from solid metal that more exactly fit their shells than previous hollow-cast versions, and the small but far from trivial innovations of the great French engineer (and inspector general of artillery) Jean-Baptiste Vaquette de Griebeauval,[122] who imbued artillery fire with more accuracy by adding calibrated sights and screw mechanisms to establish elevation with exactitude. Yet these developments did not much improve the basic ballistic performance of artillery – by Napoleon's time smoothbore artillery pieces could still usually only fire two to three rounds a minute and were not very effective beyond eight hundred yards.[123]

Although, as Keegan contends, the earliest gunpowder weapons were likely too

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[120] Volkman, p. 71; Van Creveld, p. 87.
[121] Boot, p. 4.
[122] Griebeauval also implemented organizational improvements by standardizing canon and shells (Keegan, p. 311).
[123] Boot, p. 85. It is also one of Hall's main conclusions that despite a series of innovations, there was not much improvement in the performance of firearms between the mid-sixteenth and early nineteenth centuries (Hall, p. 156).

dangerous and frightening for soldiers to dare to wield in the hand,[124] by the mid-fifteenth century European soldiers had begun to flirt with hand-held firearms, and by the sixteenth century, a weapon called the arquebus, with a stock modelled on the crossbow, had come into general use. Admittedly initially inferior in range and rate of fire to both the crossbow and longbow, the arquebus required far less training to use than a longbow and was more powerful than either mechanical weapon. The arquebus was in turn superseded by the more accurate and powerful (yet longer and thus more unwieldy) musket by the end of the sixteenth century. All of these early 'matchlock' guns were fired by means of a lit match, a process which was cumbersome and prone to misfires, so the introduction of both wheel-lock pistols[125] and flint-lock muskets, both of which used mechanical friction to generate sparks as a means of firing, were undoubtedly enthusiastically welcomed by infantrymen as their use began to spread in the sixteenth and late seventeenth centuries, respectively.[126] While guns had slowly been replacing the pike as an infantry weapon, the widespread adoption of the socket bayonet by 1700 finally displaced the older weapon on the battlefield. Yet, as with heavy artillery, despite these improvements and the massed volley-fire enabled by the development of infantry drill, hand-held firearms were still inaccurate, somewhat unreliable and of limited range – hence necessitating the unenviable tactic of lines of soldiers absorbing enemy fire and waiting till they 'could see the whites of their [enemies'] eyes' before being ordered to discharge their own weapons.

While defensive military measures are not the focus here, it is worth highlighting an archetypical example of the offense-defence dynamic. Most historians agree that, in contrast to many popular perceptions, the advent of gunpowder did not make walled fortifications obsolete – it merely changed their shape. For, less than fifty years after Charles VIII stormed through Italy, enterprising engineers had developed a new form of barrier – the *trace italienne* – that used earth and geometry to blunt the force of cannonballs, and which could withstand almost any artillery arrayed against it. The result was that in spite of the introduction of these 'revolutionary' weapons, the average length of a siege in France between 1500 and 1600 lasted a similar length of time to that

[124] Keegan, p. 328.
[125] Wheel-locks were mainly found on pistols as early as the sixteenth century – quickly becoming a favourite of horsemen as they could be used in one hand (Hall, p. 193). Yet the mechanism was both extremely expensive and fragile, which largely limited its use to noble cavalry and hunting pieces, even though it was adopted almost a century before the flintlock.
[126] To put these advances in perspective, the flintlock musket required only twenty-six tiresome steps to load, as opposed to the forty-two steps required for the matchlock version (Boot, p. 85).

of sieges in the medieval period (65 days).[127] This stalemate was in turn overcome by new siege techniques, perfected by Vauban in the seventeenth century.

In the maritime domain, the introduction of gunpowder occurred at roughly the same time as an epochal change in the nature of seafaring vessels. The age-old tactic for war at sea had been either to ram, burn or board the enemy (or a combination of these) but gunpowder allowed for more stand-off attacks. The galley, the oar-powered mainstay of Mediterranean naval warfare for over two thousand years, was first modified from the early-1500s to carry increasing, though inherently limited, numbers of cannon and then later modified to rely more on wind power by improving its sail plan[128], in the form of the galleass, before being replaced almost entirely by exclusively wind-driven ships by the seventeenth century. No longer requiring crews numbering in the hundreds, the new ships had more room to accommodate the cannon that were appearing at the time. Ships were perfectly suited as platforms for heavy cannons, since there was no further need to manoeuvre the large artillery pieces long distances once they were installed on board. The marriage of artillery and vessel got off to a rocky start, however, because initial efforts housed the cannons in pre-existing structures called castles built on the prow and stern, which strictly limited the number and weight of artillery that the ship could stably and safely carry. A pair of complementary innovations solved this problem. The development of hinged gun-ports that could keep the ship watertight when they were not in use allowed cannons to be placed below decks along the sides of the vessel, and the installation of truck carriages vastly increased the speed and efficiency with which the crew could reload the muzzles by wheeling the cannon back inside the ship after firing. These innovations allowed large ships to be built with as many as fifty large guns by 1650 and one hundred by 1800,[129] and made the broadside (simultaneously discharging all the guns along one side) the default tactic in naval engagements.[130]

The diffusion of gunpowder weapons on land and at sea was not uniform, however, and

[127] Hall, p. 211.
[128] Although many of even the earliest galleys had used sails, they had always done so opportunistically (for instance, in suitable weather conditions), and had primarily relied on oar-driven propulsion.
[129] Keegan, p. 340.
[130] The above developments did not all proceed apace, with one generation of cannons replacing the previous one *in toto*. Old and new weapons systems could coexist for some time. Hildred analyses archaeological evidence to show that in the case of one of the earliest large warships, the *Mary Rose*, the latest cannons of the time shared space with models of almost a century earlier (Alexzandra Hildred, 'The Mary Rose: A Tale of Two Centuries' in Steele and Dorland, p. 137).

examining the disparities in adoption between various peoples and polities serves as an instructive illustration of the various factors that can influence the diffusion process.

Europe

In the thirteenth century, the Mongol Empire formed a link between Asia, the Middle East and Europe and it appears as if the Europeans first learnt of gunpowder weapons from the Chinese at this time, probably via a papal ambassador to the Mongol capital[131] and others who brought samples of an array of Chinese 'fire weapons' back to Europe. These included flamethrowers, firecrackers and perhaps even early projectile weapons. Nonetheless, the Europeans had to develop the technology further on their own, a task to which they applied themselves with the greatest industry. Roger Bacon described an early formula for gunpowder,[132] and may have attempted to keep it secret, but the first records in Europe of formulae for gunpowder suitable for weapons use is found in a section of the *Liber ignium ad comburendos hostes*, attributed to 'Marcus Graecus', that dates to 1275-1300.[133] This led to a period of intense European experimentation (notably by Germans in Cologne[134]) to develop their own version of a gunpowder-activated projectile weapon. The novelty (not to mention the bluster) of these weapons seems to have aided in making most of Western Europe's rulers and military commanders aware of the early cannon, since accounts of their use come from, among others, Andalusian, French, English, Italian, Byzantine and Russian sources during the fourteenth century. By the beginning of the sixteenth century, writers such as Niccolo Machiavelli were writing – however hyperbolically – that 'the impetus of the artillery is such that a wall has not yet been found which is so strong that in a few days it will be battered down by it'[135] and news of any improvements in these wonder weapons spread rapidly via espionage, word of mouth, and newly-abundant printed materials.[136]

While knowledge of gunpowder weapons (of both the artillery and firearm varieties)

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131 Volkman, p. 68.
132 Bacon's *Epistola de Secretis Operibus Artis et Naturae et de Nullitate Magiae* (written sometime between 1248 and 1257) contains a recipe for gunpowder, part of which may have been written in code and thus intended to keep the formula secret. In any event, Hall (p. 42) maintains that the proportion of nitrate in Bacon's recipe is too low for the purposes of a projectile weapon.
133 Ibid.
134 Volkman, p.68.
135 Niccolo Machiavelli, *Discourses on Livy* (1531), Book II, chapter 17. Accessed from http://www.constitution.org/mac/disclivy_.htm on 19 April 2009.
136 McNeill, p. 123.

was ubiquitous, rulers of European cities and kingdoms still had to decide whether and to what extent to invest in the new weapons. Although conservative in many respects, Europe's leaders were eager to embrace any instrument that would give them an advantage in their almost incessant conflicts with their neighbours. Several rulers early on saw the potential for gunpowder weapons both on land and at sea and enthusiastically supported their development. In England, Edward III (1328-1377), was an early adopter and utilized primitive guns extensively in the early phases of the Hundred Years' War.[137] Over a century later, the French, spurred on by a conflict with Burgundy that broke out in 1465, began a concerted effort to improve on existing cannons and Charles VIII, like the Assyrians and Dionysus of Syracuse before him, assembled a research and development team from all over Europe.[138] Constant infighting and then Charles VIII's subsequent invasion of their principalities in turn prompted the rulers of Italy to both adopt gunpowder weapons in earnest and to put their greatest minds (men such as Leonardo da Vinci and Michaelangelo) to work in the hopes of finding a defence against cannonballs.[139] Later, rulers even institutionalized and sometimes monopolized the development of guns, as seen in the efforts of Peter the Great in Russia, England's Tower of London armoury and the advent of the Ordnance Board for naval artillery under Henry VIII. This was followed by the standardization of both drill and firearms by Maurice in the Netherlands[140] and Louvois in France.[141] It was thus primarily the rulers of Europe, driven mainly by strong interstate competition of both the military and economic kind, who made a conscious decision to adopt gunpowder weapons and further their development through government intervention.

Yet three major obstacles stood in the way of a completely smooth diffusion of gunpowder weapons throughout Europe – cost, performance, and non-strategic resistance by status quo interests. Until the 1380s, the high cost of gunpowder severely

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[137] Devries, 'Facing the New Technology: Gunpowder Defenses in Military Architecture before the *Trace Italienne* 1350-1500', in Steele and Dorland, p. 38.
[138] Volkman, p. 70; McNeill, pp. 87-88.
[139] Parker (pp. 9-10) cites M.E. Mallett, 'Diplomacy and war in later fifteenth-century Italy,' *Proceedings of the British Academy*, LXVII (1981), 267-88, at p. 270 who quotes the Venetian Senate in 1498 as bemoaning that 'the wars of the present time are influenced more by the force of bombards and artillery than by men at arms'.
[140] McNeill, p.140.
[141] In eighteenth century France, Gribeauval even tried to systematize the *improvement* of artillery in what McNeill refers to as 'command technology', although McNeill admits that this kind of regularized weapons development was exceptional in European military establishments of the time (McNeill, p. 173-174). Further, McNeill asserts that once the use of handheld firearms was routinized and standardized in an army, it became more difficult to introduce changes, since any innovations had to be accepted on a large scale (instead of just a trial segment of weapons), which was extremely costly (p. 141).

limited the use of the new weapons, but this was remedied when cheaper sources of saltpetre were discovered. Later, the cost of bronze made cannons expensive to make, at least until the appearance of iron-cast artillery alleviated these costs. Yet relative expense was not the primary impediment to diffusion.

Initially, at least, in spite of their power and the shorter training required, the performance of early handguns was far surpassed by the longbow and crossbow in terms of range, rate of fire, accuracy and reliability, and that of early artillery was inferior to the performance of existing mechanical devices. This remained so for at least a century after the introduction of the first firearms and cannon around 1330. A few key technological developments, however, including the corning of gunpowder, the casting of bronze cannon and the flintlock, together with a gradual revision of organization[142] and battlefield tactics to incorporate the new weapons, vastly improved gunpowder weapon performance, eventually superseding that of the bow and the trebuchet. The obvious question then is: why did artisans and commanders persevere with what was clearly at the time an inferior military technology? Far-sightedness by rulers regarding the ultimate potential of gunpowder and psycho-sexual attachment to firearms[143] may be part of the answer, but neither seems sufficient to explain more than a century of dogged experimentation. I am more convinced by Hall's argument that the new weapons performed just well enough to convince decision-makers that continued investment was worthwhile – that the 'killer app', in the modern vernacular, was just around the corner. As he maintains in the case of *bombards*, 'the siege gun did not always achieve a speedy resolution, but it seems to have done so often enough to be credible. And credibility, that most subtle of psychological factors, should not be underestimated.'[144]

Less tangible sources of resistance, however, remained. The first guns, with their booming noise and sulphurous smoke were perceived by many as rather devilish and cowardly devices, but as familiarity with the weapons grew, this view subsided. In certain instances, however, there was also the social conservatism of the functional

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[142] For example, Hall illustrates how, during the fifteenth century, '[b]etter management, organization, and logistics seem to have played more of a role [in artillery's improved performance] in most cases than did better ballistics' (Hall, p. 106).
[143] McNeill suggests that the sexual symbolism of guns may have played a role in the seemingly 'irrational investment' by European craftsmen and rulers in early firearms, but then admits that this cannot be the entire explanation since such symbolism must have been present in other cultures that were not quite as enthusiastic adopters of firearms (McNeill, p. 83).
[144] Hall, p. 65.

descendants of the medieval warriors, the aristocrat-dominated cavalry, to contend with. They initially took an even harsher view of handguns than their forebears had of longbows and crossbows. For example, Baumgartner describes the stubborn French resistance to the incorporation of arquebuses onto the battlefield in the late fifteenth and early sixteenth centuries, even when it put them at a military disadvantage relative to the Spanish and Italians.[145] This rejection of the new was born of a desire to keep the individual warrior spirit and hand-to-hand skills alive on the battlefield, while ignoring the fact that infantrymen acting as a cohesive unit and using both pike and firearm could now demolish any armour worn by mounted men-at-arms. Similar seemingly irrational motives are also sometimes ascribed to later innovations in gunpowder weapons, for example, Prussian gunners were described as possessing 'a certain gigantism' in which heavier artillery was preferred even if it was not as effective or efficient as smaller cannon.[146]

In any event, it was raw experience that put paid to this resistance – the constant improvements in performance made the superiority and military necessity of gunpowder weapons undeniable. Nevertheless, although gunpowder weapons gradually displaced mechanical projectile weapons completely in Europe, this process was sometimes fitful and was only completed in the first quarter of the seventeenth century – almost 400 years after the first introduction of gunpowder weapons into Europe.

How militaries adapted to the new artillery and handheld weapons is almost as important as whether, why and when they did so. Like many new weapons, those based on gunpowder emerged in an existing military context and it was within this context that their tactical and strategic deployment was first conceived. Initially then, cannon were used in much the same way as mechanical siege engines and arquebuses in a similar fashion to crossbows and longbows. Handguns like the arquebus, for example, were at first mainly popular for use by the defenders of fortresses.[147] Any 'revolutionizing' of warfare only occurred over time, as the new opportunities afforded by these weapons (such as the use of artillery in the field or infantry volley-fire) began to be exploited by

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[145] Frederick J. Baumgartner, 'The French Reluctance to Adopt Firearms Technology in the Early Modern Period', in Steele and Dorland, pp. 82-83. There are several examples where the French were disadvantaged by Spanish and Italian arquebusiers, including the Battles of Cerignola (1503), Sesia (1523) and Pavia (1525).
[146] Showalter, p. 189.
[147] I am indebted to Hall (p. 16) for setting me along this line of thinking.

military commanders. In other cases, the novelty of the weapons meant that new tactics had to be developed rapidly, sometimes in the heat of battle, as was the case in 1588 when English captains were forced to improvise (at least to some degree) so-called 'sail-and-shot' tactics against the Spanish Armada.[148]

Although gunpowder weapons did not always perform as intended on the European battlefield,[149] even in their early incarnations they were at times decisive, as in Charles VIII's aforementioned conquest of Italy, not to mention Gustavus Adolphus' later canny integration of artillery and musket-fire at Breitenfeld in 1631. However, it was in combat with non-European powers that the European advances in gunpowder weapons became readily apparent, starting with the Spanish defeat of the Moors' fortresses in Grenada (1482-92) and becoming even more glaring when European warships, with their superior cannon, sailed the oceans to conquer much of the known world between the sixteenth and nineteenth centuries.

The Middle East and North Africa

The Muslim lands of the Near East may have experimented with gunpowder weapons borrowed from the Chinese even earlier than Europe, as indicated by the appearance in 1118 in some Muslim armies of a contraption called the *madfaa*, which consisted of a wooden pot containing gunpowder and plugged by a stone ball. Needless to say, the *madfaa* was both extremely dangerous – wood and explosions do not make good bedfellows – and almost wholly ineffective, mostly because there was no way to predict where the ball would land.[150] This early experiment apparently went nowhere and Muslim armies had to resort to emulating the weapons of Western Europe. So it was that in 1453, enormous bombards proved to be pivotal in the Islamic conquest of Constantinople, but these were almost entirely built and operated by Hungarian mercenaries from Europe.

It was not that Muslim rulers failed to see the tremendous military benefits of both siege

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[148] Boot, p. 28. Although Boot asserts that the British first conceived of the line-ahead broadside during battle against the Spanish Armada, Guilmartin describes an earlier altercation in 1557, when the British were themselves exposed to broadside fire from the Portuguese force during unsuccessful attempts to use the traditional tactic of closing and boarding the Portuguese vessels (Guilmartin, pp. 101-110).
[149] An example of gunpowder weapons not quite meeting expectations is Frederick the Great's creation in 1759 of horse artillery, which did not prove too useful in battle (Showalter, p. 189).
[150] Volkman, p. 68.

cannon and handguns; indeed the Ottomans in particular were avid adopters of gunpowder weapons, especially under the sultans Mehmet II in the fifteenth century and Bayezit II in the sixteenth.[151] These weapons were especially helpful for subduing local enemies.[152] The problem stemmed from a reluctance to modify existing practices to fully integrate gunpowder weapons and a failure to encourage further development of these weapons to keep pace with advances elsewhere. This was not due to any technical failings – Arab scientists (at least up to the sixteenth century) were capable of reverse engineering any weapon that fell into their hands. Rather, the failure to properly adopt and adapt gunpowder weapons was rooted in cultural chauvinism and religious orthodoxy.[153]

The cultural chauvinism is nowhere better illustrated than in the case of the Mamluks in Egypt at the beginning of the sixteenth century. The Mamluk ruling class prided itself on its horsemanship and skills with the sword and the compound bow and had relied on these traditional weapons to successfully overcome what they viewed as an upstart group of black slaves whom their sultan had equipped with firearms in 1497.[154] When confronted by Portuguese warships with heavy cannon in the Red Sea, as well as Ottoman forces that were well-armed with musketeers and artillery on Egypt's borders, the Mamluk sultan ordered the casting of large numbers of cannon and the formation of musketeer units.[155] Yet the ruling Mamluks themselves refused to use these weapons, but recruited gunners and musketeers from black Africans and people of the Maghreb, while themselves retaining their traditional weapons. Unsurprisingly, this half-hearted and Johnny-come-lately adoption effort resulted in the Mamluk armies suffering complete defeat at the hands of the Ottomans in the battles of Marj Dabiq (1515) and Raydania (1516),[156] after which the Mamluk leader Kurtbay is reported to have lamented that 'A single one of us can defeat your whole army. If you do not believe it, you may try, only please order your army to stop shooting with firearms…The

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[151] Nafziger and Walton, p. 13.
[152] Barton C. Hacker, 'Gunpowder and the Changing Military Order: The Islamic Gunpowder Empires ca. 1450 – ca. 1650', in Steele and Dorland, p. 87. One example of the effective utilization of gunpowder weapons by Muslims was the routing of the Songhai Empire by the forces of the Moroccan Sa'adis in 1590-1591. See Parker, p. 174 and John Hunwick, *Timbuktu & the Songhay Empire: Al-Sa'dis Ta`rikh al-sudan down to 1613 and other Contemporary Documents* (Leiden: Brill, 1988).
[153] Parker is one of the only scholars to offer a third explanation for Islamic failure to properly adopt gunpowder weapons – that the metal from which Islamic weapons were constructed was brittle and their weapons thus inferior to those of the Europeans (Parker, p. 128).
[154] Keegan, p. 38.
[155] Keegan, p. 36; Parker, pp. 126-127.
[156] Ibid.

contrivance is that musket which, even if a woman were to fire it, would hold up such and such a number of men … And woe to thee! How darest thou shoot with firearms at Muslims!'[157]

A strict religious orthodoxy, spearheaded by ideologues such as the previously mentioned al-Ghazali, did permit the emulation of the *objects* offered by the infidel world. The social and organizational changes that were required to put gunpowder weapons to optimal use were another matter entirely. Moreover, scientific advances were viewed as potentially subversive and their dissemination was strictly controlled by the ruling classes in the Middle East. This fear of religious taint may have accounted for the fact that many of the Ottoman janissaries who were equipped with arquebuses in the fifteenth century were recruited from among Christian subjects in the Balkans.[158]

In essence, although the Ottomans possessed few inhibitions about adopting the hardware of the Gunpowder Revolution, they were unwilling to adopt the corresponding military software related to new approaches to science and organization,[159] becoming, in Parker's words 'expert imitators, but poor innovators'.[160] Much later, when Von Moltke was sent in 1835 to assist the Ottomans in military modernization, he found that this attitude was still evident, as can be gleaned from his remark that 'a Turk will concede without hesitation that the Europeans are superior to his nation in science, skill, wealth, daring, and strength, without it ever occurring to him that a Frank might therefore put himself on a par with a Muslim'.[161]

While the widening military disparity between the Christian and Islamic worlds in the early modern era was by no means solely the result of an incomplete adoption of gunpowder weapons, the inferiority of Muslim weaponry played a large role in the growing litany of Muslim defeats at the hands of Europeans, including major battles such as Lepanto (1571),[162] Vienna (1683), and the Battle of the Pyramids (1798).

157 Keegan, p. 37, quoting from D. Ayalon, *Gunpowder and Firearms in the Mamluk Kingdom* (London: Vallentine, 1956), pp. 94-95.
158 Steele and Dorland, p. 15.
159 Ibid, p. 16 and Gabor Agoston, 'Behind the Turkish War Machine: Gunpowder Technology and War Industry in the Ottoman Empire 1450-1700' in Steel and Dorland, *passim*.
160 Parker, pp. 126-127.
161 Keegan, p. 39.
162 At Lepanto, six better-armed Venetian galleasses were reported to have sunk seventy Turkish galleys (Parker, p. 87).

South Asia

Gunpowder had reached the Indian subcontinent by the mid-1300s at the latest, if not earlier, probably facilitated by the Mongol conquests. By the sixteenth century, the various South Asian kingdoms and empires were manufacturing their own firearms and artillery. Many of the rulers of the various Indian kingdoms (including the Mughals) sought the expertise of foreign experts, including Turks and Europeans and supplied their arsenals with a variety of gunpowder weapons. However, the core of the subcontinent's armies was centred on the cavalry and it is argued that, until the mid-eighteenth century, there was a 'complicit symmetry' between local forces in which the cavalry was permitted to retain pride of place in battle, with flintlock firearms not really utilized to their maximum ability.[163]

When European interlopers from Portugal, France and predominantly Great Britain began to encroach on Indian territory from the seventeenth century on, they did not share these traditional practices and the Indian princes endeavoured to use their gunpowder weapons more effectively. Initially, the quality of the local artillery was mediocre at best, which had become apparent to the local rulers in their first few engagements with European forces. Therefore, by employing European craftsmen and advisors, they increased artillery quality and began arming their infantry in earnest with flintlock muskets. Yet even with this 'crash-course' weapons development, the local rulers of the subcontinent were ultimately unable to replicate the efficiency in firepower of their erstwhile European colonizers. The reason for this did not seem to lie in a rejection of outside practices to the same degree as in the Muslim case, but rather in an inability to properly incorporate gunpowder weapons into indigenous fighting traditions, despite a willingness to do so. So, while Arthur Wellesley would proclaim after the Battle of Assaye in 1803 that the bronze cannon of the Maratha Confederation was 'so good…that it answers for our service',[164] the inability of the chieftains during the battle to make effective use of this artillery represented a fatal flaw in doctrine.

By means of comparison, the British succeeded in conquering India using mainly

[163] Bryant, p. 469.
[164] Arthur Wellesley to Henry Wellesley.

sepoys (native infantrymen who fought for the British) trained and armed according to contemporary European levels. However, the British attempted to adapt these techniques to local cultural traditions,[165] and succeeded for the most part, at least if measured by their military successes up to the first decades of the nineteenth century. Tellingly, when the Imperial masters in London expressed concern to their local commanders that arming and training the sepoys with the latest guns might lead to dissemination of British military practice to the enemy, the local commanders retorted that the Indians had already had skilled Europeans at their disposal for many years, but had still failed to reach parity with the quality of British arms and doctrine.[166]

In short, at least after 1750, it was more the lack of capable commanders who knew how to best employ gunpowder weapons and the stasis of traditional military doctrine, rather than any technical or resource-driven constraints, which proved the undoing of the indigenous kingdoms of the subcontinent.

Native Americans in the New England Colonies of North America

The indigenous inhabitants of the New England colonies, although having no experience with gunpowder weapons prior to 1620, quickly recognized the advantages of a musket over a bow in terms of speed, directness and penetrating power. Unlike the majority of colonists, the Native Americans further saw the advantages of flintlock over matchlock guns in the forested areas of New England.[167] Moreover, through apprenticeships to English craftsmen and other means, they soon procured the skills needed to repair firearms and even cast their own ammunition.[168]

In contrast to several other cultures around the world, there was no resistance to adopting these new weapons. Quite the opposite – as soon as the local tribesmen realized the superiority of European weapons and technology, they made every effort to acquire it.[169] In fact, objects of European origin actually enhanced the status of Native American warriors.[170] At the same time as they were acquiring English skills in

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[165] J. A. Lynn, 'Heart of the Sepoy', in Lynn (ed.), *Tools of War*, p. 60.
[166] Bryant, p. 459.
[167] Malone, p. 35.
[168] Ibid., pp. 68-70.
[169] In addition to firearms, they also welcomed the use of steel hatchets.
[170] Malone, p. 25.

maintaining and repairing firearms, the local Native American braves were arguably surpassing the colonists' skills and tactics in using them. They became adept sharpshooters, in a culture where 'accuracy could have a mystical aspect'[171] and quickly developed tactics alien to the European battlefield – stealth, surprise, high mobility and shooting from behind the cover of rocks, trees and brush.

Firearms began to diffuse rapidly through the tribes of New England, since any tribe that did not adopt the new weapons suddenly found itself at a serious military (or at least prestige) disadvantage with respect to its neighbours.[172] This alarmed many of the colonists[173] who attempted to ban the sale or transfer of firearms to Native Americans, by appealing to the Crown and enacting a series of what would ultimately prove ineffectual prohibitions on the transfer of firearms and other European weapons (the Dutch, French and even many of the English colonists simply ignored the enactments). By the late 1660s, these restrictions had largely been abandoned and the diffusion of arms to Native Americans escalated further, so that by the outbreak of King Philip's War in 1675, most warriors were amply equipped with flintlock muskets and pistols. Furthermore they had experience with these weapons and had adapted tribal combat systems to accommodate the advantages and constraints presented by firearms.

The great Wampanoag sachem Metacomet (referred to as 'King Philip' by the English) launched an insurrection against the colonists in June 1675, which quickly involved surrounding tribes and has become known as King Philip's War.[174] While the Europeans were wedded to traditional volley tactics and single-shot musket balls, the Native Americans engaged in guerrilla warfare, relying on cover, accuracy and dispersed shot to confound the English in the dense forest environment. The Native Americans inflicted heavy losses on the English, who only began achieving some success when they mimicked the tribal warriors' tactics and enlisted the help of native allies.[175] Despite their tactical success, by 1676 the insurrectionists were overcome by

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[171] Ibid., p. 64.
[172] Malone, p. 41.
[173] One William Bradford of Plymouth noticed the local Wampanoag tribe's interest in firearms and remarked that after they 'saw the execution that a piece [a musket] would do, and the benefit that might come by the same, they became mad (as it were) after them and would not stick them to give any price they could attain to for them; accounting their bows and arrows but baubles in comparison of them' (*William Bradford, Of Plymouth Plantation 1620-1647*, edited by S.E. Morison (New York, 1967), p. 207, cited in Malone, p. 31).
[174] Malone, p. 2.
[175] Parker, p. 119; Malone, p. 88.

disease, starvation, and far more numerous and well-supplied opponents. Nevertheless, the Native Americans of New England had not only adopted the firearm, they had imaginatively adapted it to the local environment in a manner not foreseen by its originators. As Malone maintains: 'The Colonists had brought the firearm to the New World; in King Philip's War, the Indian would demonstrate how to use this machine.'[176]

East Asia

The Far East presents a curious set of cases of diffusion and innovation with respect to gunpowder weapons. In addition to serving as the fountainhead of the Gunpowder Revolution, the region offered a range of innovations, from Admiral Yi's ingeniously formidable 'turtle ships'[177] in Korea, to early forms of volley-fire in Japan. How then did an initial flowering of armaments become largely surpassed by Europe by the end of the sixteenth century? Starting with China, a string of early developments in artillery, handguns and ship-borne weapons made it arguably the most advanced military power on earth by the middle of the fourteenth century, when European arms-makers were still tinkering with primitive cannon. In the latter fifteenth century, however, China turned inward, cementing government control and stifling much innovation.[178] The famous self-destruction of its mighty sea-going vessels and prevention of the further development of well-armed ocean-going warships is a well-worn story of bureaucratic short-sightedness. Chinese armies were also huge by comparison with European militaries of the same time and decision-makers may have believed there to be little need (not to mention insufficient resources) to equip all its soldiers with firearms. Therefore, although the use of cannon and firearms persisted in China, these did not develop much further and traditional weapons dominated right through to the nineteenth century.[179] The result of this lack of dynamism was that, by the sixteenth century, China and the rest of the Far East had been overtaken in the development of gunpowder weapons by the Europeans and were forced to look to European explorers and traders to learn of the latest innovations in firearms and artillery.

[176] Malone, p. 66.
[177] Parker, p. 109.
[178] China's introversion applied mainly to its maritime borders – indeed one of the reasons for its move away from its oceanic interests was that more resources were required to address threats from Mongols and other nomads on its northern borders.
[179] Parker, p. 137.

The Japanese experience with gunpowder weapons shares some parallels with that of the Chinese, but also some remarkable differences. First made aware of Western firearms from the Portuguese in 1543, the Japanese adopted them with far more zeal than their neighbours to the west. By 1575, during the Japanese civil war, the warlord Oda Nobunaga fielded over three thousand musketeers and directed them to utilize ranks and volley fire several decades before this tactic became popular in Europe.[180] Unlike the Europeans, however, Japanese tactics stressed accuracy over rate of fire. By the time the reunification of Japan was finally consolidated by one of Nobunaga's successors, Tokugawa Ieyasu, in 1616, firearms had played a major role. Then a development occurred that has few parallels in the history of weaponry – the new Tokugawa shogunate introduced drastic changes, starting with the destruction of almost all fortresses in Japan, then closing the country to outside influences and, most relevant to the current discussion, all but outlawing firearms for almost another two hundred and fifty years. Keegan has advanced several explanations for this behaviour, viz., the association of guns with the West and the Christian religion which Japan's rulers found threatening to its traditional society; the firearm, by empowering commoners, was seen as socially destabilizing; gun control in Japan's relatively isolated and homogenous polity was a viable policy; gunpowder was seen as antithetical to the samurai warrior ethos; and gunpowder weapons challenged the Japanese affinity for the purity of muscular effort, which was perceived as being in harmony with the natural world, something which the artificial chemical reactions of gunpowder are not.[181]

Over the next hundred years, the Japanese government imposed stricter and stricter forms of gun control until by the end of the seventeenth century firearms had almost completely ceased to be used in Japan, with all existing weapons and related knowledge closely held by the shogunate until the forced opening of Japan by Commodore Perry in 1854.

The experiences of China and Japan with respect to the diffusion of firearms in the early modern age thus provide clear demonstration that when new weapons challenge deeply-held cultural, political, or social mores, their adoption is by no means guaranteed, even where these weapons might bestow large or even vital military advantage.

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[180] Parker, p. 140.
[181] Keegan, pp. 44-45.

Summary

It took a period of over four centuries for the world's warfighters to adequately adjust to weapons driven by explosive chemical reactions, weapons which amplified the power of destruction several orders of magnitude over that of muscle and mechanics. The advent of gunpowder weapons did not consist of a single innovation, but a series of improvements, some incremental, others seismic, that overcame most (but by no means all) of the technical and tactical problems presented by trying to confine an explosion in a metal tube.[182] Nor was the diffusion of these weapons uniform or successfully implemented in all quarters.

Renaissance Europe proved to be the most dynamic adopter of gunpowder weapons. It was a font of new ideas, many of which could not even be realized with the materials and tools of the time, and this creativity extended to the operational military sphere despite the lack of a formal scientific approach to invention. The desire to perpetually improve their weapons was emblematic of the age in another way, with polities being galvanized by the widespread political instability on the Continent into always seeking a new technical or tactical advantage. These forces provided a sufficiently powerful impetus to overcome inherent conservatism and entrenched ideas about warfare.[183]

This was not so in all locations to which cannon and firearms spread. The Islamic world of the Middle East and North Africa would not, while the indigenous inhabitants of South Asia could not, accept the organizational, doctrinal and invariably social corollaries to the adoption of the weapons themselves, being, as these were, antithetical to extant warrior cultures. It was in this sense not a failure to adopt the weapon, but the weapons system, that resulted in what can be termed a partial diffusion of gunpowder weapons to these cultures. The Native Americans of New England were far more

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182 Yet, while the innovations in gunpowder weapons were collectively dramatic when viewed from the comfort of hindsight, they were sufficiently protracted that most commanders during the period would use essentially the same weapons for their entire military careers against similarly-armed opponents (see Van Creveld, p. 97). Therefore, although technology undoubtedly bestowed significant military advantage (especially when the disparity in weaponry between opposing forces was great), one must be cautious not to overlook the place of generalship, logistics, or even wider social, economic and political developments in the age's battlefield outcomes.

183 As Dunnigan observes, 'Unlike the Chinese, and many ancient societies, the Europeans didn't just think up a lot of new ideas, they enthusiastically went out and put them to use. Then they devised variations and improvements and just kept on going' (Dunnigan, p. 10).

successful in their adoption of firearms, but alas were beset by more fundamental immunological and numerical weaknesses, while the East Asians more or less voluntarily surrendered their early achievements with respect to gunpowder weapons and tactics. It is thus no surprise that the Europeans' successful adoption of gunpowder weapons and the successive technical and tactical innovations needed to properly exploit these weapons are often pointed to as a key lever in Europe's global ascension.[184]

The Industrialization of War

Warfare at the end of the eighteenth and beginning of the nineteenth centuries was dominated by Napoleon's quest for supremacy in Europe. Yet the innovations heralded by the diminutive Corsican were above all organizational and political – the plenitude and passion of the *levee en masse*, the competence of a meritocratic officer corps and tactical wizardry with columns of men – rather than technological. There were few if any developments in weaponry during this period of what John Lynn refers to as a 'complicated interaction of intellectual and institutional factors in a static technological environment'.[185] Indeed, historian Russell Weigley has gone so far as to declare that '[t]he hardware of war was essentially the same in 1815 as in 1631'.[186]

Even those few weapons innovations that did emerge during this period were largely stillborn at the hands of technologically conservative commanders. Napoleon famously disbanded the French balloon observation corps in 1799,[187] despite the potential of the Montgolfiers' relatively recent invention to serve as a reconnaissance and possibly even a weapons platform. He also squandered Robert Fulton's offer to develop a submarine for combat purposes, including the first torpedoes, by cutting off Fulton's funding after only one year, even after the inventor had produced promising prototypes.[188] Napoleon was not the only leader to eschew novel, yet potentially useful, weapons – his nemesis, the Duke of Wellington, refused to employ the new Congreve rockets on the battlefield.

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[184] In 1450, Europeans controlled just 15% of the world's landmass – by 1800, this had more than doubled to 35%, and to an astounding 84% by 1914 (Boot, p. 20).
[185] J.A. Lynn, 'Preface' in Lynn, p. ix.
[186] Russell F. Weigley, *The Age of Battles: The Quest for Decisive Battles from Breitenfeld to Waterloo* (Bloomington: Indiana University Press, 1991), p. xvi.
[187] McNeill, p. 220.
[188] Volkman, pp. 139-140.

These rockets, which were somewhat inaccurate but still useful against large targets such as towns and forts, were themselves the product of an interesting diffusion process. Their inventor, William Congreve, learnt from accounts of the Mysore Wars in India that Tipu Sultan and his father, Haider Ali, had harried the British with their extensive use of rockets. From captured rocket casings, Congreve set about designing his own larger and more powerful versions using a new propellant, the first successful testing of which occurred in 1805. This in turn led to their use in several battles, including the attack on Fort McHenry during the War of 1812, after which Congreve's rockets became immortalized in the American national anthem. Yet, despite their greater range than contemporary artillery, their inaccuracy meant that they were little used in the second half of the nineteenth century and only made a comeback in World War II.[189]

It was only in the years leading up to the Crimean War (1853-1856) that significant innovations in weaponry occurred. The rapid spread of these and subsequent innovations, which included breechloading, easier-to-use rifles, machine guns and later (at the beginning of the 20th century) naval dreadnoughts, was to a great extent facilitated by a larger societal change – the quantum leap in industrialization that began in the late eighteenth century and has often received the moniker of an 'Industrial Revolution'. The early part of this rapid growth in industrialization was dominated by radical improvements in power technology as machines and workers combined into integrated, increasingly productive systems.[190] This change does not seem to have had a significant impact on weapons technology until it was supplemented by a related development – the so-called 'American System' of manufacturing in which precision machine tools and automation were combined to mass produce complex products from sets of interchangeable parts.[191] Among the pioneers of these techniques were American firearm companies in the Connecticut Valley, demonstrating once again the ironic synergy between military and civilian production; the same technologies that would for the first time make a host of consumer products affordable and thus enrich the lives of large portions of humanity, would simultaneously greatly enhance the capacity for ending those same lives. By the mid-nineteenth century, large numbers of standardized

[189] McNeill (p. 220) cites Willey Ley, *Rockets, Missiles, and Men in Space* (New York: Viking Press, 1968), pp. 61-75 and Wernher von Braun and Frederick I. Ordway III, *Rocketry and Space Travel*, 3rd ed. (New York: Crowell, 1975), pp. 30-34.
[190] See Mokyr (1990), p. 92 for further discussion.
[191] Mokyr (1990), p. 136; McNeill, p. 331.

weapons of identical quality could be produced in a short space of time using these techniques – the British Woolwich Arsenal by the 1850s could produce 250,000 rifle cartridges per day.[192] One of the important consequences was that an entire army could be equipped with a new weapon relatively quickly, which drastically shortened the interval between different generations of weaponry. It also appreciably lessened the penalty for investing in the wrong weapon or technology, since adoption mistakes, while costly, could be rectified without setting the military at a long-term disadvantage.[193]

Another aspect of these developments is the changing role of private industry in weapons innovation and production. During previous centuries, weapons innovation had sometimes been encouraged or even monopolized by rulers, but had also been the province of guilds and even individual armourers, depending on the period and weapon. In the nineteenth century, the onus – at least in Europe and North America – first shifted towards private producers. It was up to the individual inventor to create a prototype and try and sell it to one or more governments, who would often only adopt the innovation once it had been proven in use elsewhere or in the civilian sector.[194] The private businessman took responsibility for spotting a need or an opportunity and addressing it, as well as bearing all the risk and initial costs. At the same time, military officials were often deluged with offers for new weapons, many of which were outlandish and unsound, leading to much scepticism of claims for weapons innovations and a robust conservatism. After 1880, however, there arose a new era of 'command technology',[195]starting with naval vessels and equipment, whereby military officers set out the parameters for new weapons and invited private producers to come up with suitable designs and innovations. This meant that weapons innovation was at least to some extent driven by the perceived needs of military leaders, rather than being completely dependent on the whims of inventive outsiders. This state of affairs has continued through to the present day.

The Industrial Revolution and the production methods accompanying it did not diffuse worldwide, at least not immediately. This meant that the mass production of weapons

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[192] Keegan, p. 312.
[193] See McNeill, p. 235 for a similar notion.
[194] McNeill, p. 224.
[195] McNeill, p. 278.

was limited mainly to Europe and North America, which only served to widen the military gap between countries in these regions and most of the rest of the world. The Muslim world, for example, beset by would-be European colonizers at every turn, may have been able to buy and use modern weapons, but they could not manufacture them in bulk or improve upon them, which put them at the mercy of their supply chains. One exception was Japan – the Meiji Restoration that sought to rapidly modernize Japan in the latter half of the nineteenth century entailed the rapid assimilation of Western science and technology and included the emulation and production of Western arms.

Several developments in both small and large guns made good use of these advances in production. The first of these was the widespread adoption of rifled barrels. The additional accuracy and thus range resulting from the spin imparted by grooves in the barrel to the bullet had been known for some time, and indeed rifles (as these guns came to be known) had been in occasional use since the sixteenth century. The major problem, in addition to the increased cost, was that in order for the round shot to engage the grooves, there had to be a very tight fit between ball and barrel, which made it more difficult to push the ball down and thus made the rifle's rate of fire far lower than that of the smoothbore musket. However, when combined with an elongated, conical bullet with a hollow base (designed in 1843 by the Frenchman Claude Etienne Minié) and the percussion cap (which obviated the need for a flintlock mechanism), the rifle could really come into its own. Adoption was almost immediate: within 15 years of the introduction of Minié's system, France, Britain, Prussia, and the United States had adopted rifling.[196] Those who failed to adopt these new weapons *en masse* were punished for their lassitude – the Russians were at an acute disadvantage during the Crimean War against French and British rifles that had an effective range five times further than their own smoothbore weapons.[197]

It was also during this conflict that another innovation came to the fore. The Prussians were among the first to equip their infantry almost completely with a breechloading rifle.[198] Easier to load than muzzle-loading weapons, breechloaders enabled soldiers to

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[196] McNeill, p. 232.
[197] For a full description of the usefulness of rifles in the Crimean War, see Hew Strachan, 'The British Army and "Modern" War: The Experience of the Peninsula and of Crimea', in J.A. Lynn (ed.), *Tools of War*, p. 212.
[198] Geoffrey L. Herrera and Thomas G. Mahnken, 'Military Diffusion in Nineteenth Century Europe: The Napoleonic and Prussian Military Systems' in Goldman and Eliason, p. 220.

reload from a crouching or lying down position (and thus reduce the enemies' target) and also allowed for a far greater rate of fire than previous firearms. On the battlefield this effectively multiplied the amount of firepower a given number of soldiers could bring to bear, or conversely reduced the number of soldiers necessary to effectively combat an opposing force armed with muzzle-loading rifles. Previously, firearms that were loaded from the breech were too prone to misfires, but the new methods of precision machining allowed for the creation of a viable weapon. Christened the needle gun (or *Zündnadelgewehr* in the original German), this remarkable weapon had been developed by a German craftsman named Johann Nikolaus von Dreyse over a twenty-year period starting in 1820.[199] Dreyse was able to persevere in large part due to financial support from the Prussian military. It took a full twenty-six years for the entire Prussian army to be equipped with the needle gun, but by the time its effectiveness became apparent in 1866 against Austria, production techniques had improved so much that it took only four years to duplicate this feat with a new generation of rifles. The Austrians, despite plenty of opportunity, failed to incorporate breechloaders into their tactical repertoire and suffered in their war with Prussia in 1866. Austria had rejected breechloaders for fear that their high rate of fire would encourage soldiers to waste their ammunition, a result the Prussians avoided through excellent training.

Further innovations in firearms during the latter half of the nineteenth century included the development of a metal cartridge combining powder and bullet and repeating rifles, which used a bolt-action mechanism to reload a new bullet from a magazine each time the gun was fired, thereby allowing for an even more dramatic increase in the rate of fire.[200] Last, the invention of smokeless gunpowder (Poudre B and then Cordite) meant that the literal 'fog of war' that had obscured battlefields for hundreds of years would no longer be a problem; nor would it be an easy matter to locate a concealed enemy by looking for the tell-tale puff of smoke that the old black powder had released when fired. Moreover, the smokeless powders left residues that were far less deleterious to the weapon, thus making automatic weapons feasible. These improvements in gunpowder were driven in large part by government-supported programs of experimentation and applications of science to war.[201]

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[199] Boot, pp. 128-129.
[200] Early models included the Winchester and Spencer rifles from the United States and the British Lee-Metford (Boot, p. 149).
[201] Seymour H. Mauskopf, 'Chemistry in the Arsenal: State Regulations and Scientific Methodology of Gunpowder in Eighteenth Century England and France', in Steele and Dorland, p. 315.

Even outside of Europe the more astute amongst military men soon discovered the utility of rifled arms, among these the Turks and Boers, who put their repeating, breechloading rifles to good use in 1877 and 1899 respectively.[202] The Anglo-Boer War in particular provided an example of the necessity for armies to be equipped with the most modern firearms, for a small technological asymmetry between the two forces nearly upset the mighty British Imperial Army. The more modern Mauser rifles of the Boers used clips of five bullets[203] whereas the ammunition for the British army's Lee-Enfield MLE rifle had to be inserted singly into its magazine, thus making reloading much easier and faster for the Boers. This helped to offset some of the numerical disadvantage in which the Boers found themselves during individual battles and, when combined with the Boers' superior marksmanship and tactics of defensive entrenchment, led to several surprising early battle victories for the Afrikaners. Although the British ultimately won in South Africa, victory was accomplished at arguably a much greater cost – the war cost Britain at least a whopping £223,000,000 and with 448,000 men participating[204] it was the largest overseas deployment in British history – than might have been the case had they enjoyed parity with the Boer's Mauser rifles.[205]

The rate of fire also reached a relative apogee in the nineteenth century with the development of the first true machine gun by Hiram Maxim in 1884, which built on semi-automatic predecessors, namely the American Gatling gun and the French *mitrailleuse* of the 1860s and 1870s, respectively. The Maxim gun, which could fire at a rate of 600 rounds per minute,[206] amounted to the most devastating anti-personnel weapon yet devised, mowing down less well-equipped opponents in clashes such as that at Omdurman in 1898. It is interesting that the European powers sought to create and maintain a monopoly on these new weapons. For instance, to prevent non-Europeans

[202] Sir Michael Howard, 'Tools of War: Concepts and Technology', in Lynn (ed.), p. 244.
[203] S. Slocum, 'Extracts from the reports of Captain S L'H Slocum, Eighth Cavalry, on operations of the British Armey' in *Boer War operations in South Africa 1899-1902*, The First Scripta Africana Series facsimile reproduction (Johannesburg: Scripta Africana, 1987), p. 81.
[204] F.T. Stevens, *Complete History of the South African War, 1899-1902* (London: W. Nicholson & Son, 1902), p. 399.
[205] Of course, Boer successes and British setbacks during the war were affected by a host of other factors, including British strategic blunders, superior intelligence collection and defensive tactics by the Boers, guerrilla warfare and disease to name just some, but the superior firearms of the Boers, whose adroit tactical adaptations extracted maximum advantage from small discrepancies, played pivotal roles in all stages of the war.
[206] Keegan, p. 312.

from learning how to use the machine gun, they did not allow even the non-Europeans fighting on their behalf to operate machine guns.[207]

With respect to heavy artillery, the development of the Bessamer process for producing high-quality steel and advances in the configuration and composition of propellant charges resulted in the construction of far larger and more powerful guns by men like the German steelmaker Alfred Krupp. Adding explosive shells only increased their destructive power. Despite much scepticism towards many of these developments on the part of European military leaders, after the successful showing of new Prussian artillery in the Franco-Prussian War of 1870 to 1871, European armies were quick to replace their bronze muzzle-loaders with breech-loading steel guns.[208] Artillery soon came to be the primary weapon on the battlefield, and the relative immobility resulting from the massive size and weight of steel breechloaders meant that the defence became paramount. There was one significant problem – the longer range of the rifle brought the opposing artillery crews into danger, a problem that would only be solved when the advent of theatre communications enabled commanders to station artillery in the rear, safe from snipers, and communicate the enemy's positions to the artillery crews by means of the field telephones in what came to be called 'indirect fire'.[209] Moreover, by the end of the nineteenth century, the introduction of a recoil system enabled the introduction of far smaller, yet equally if not more powerful, artillery pieces that were highly mobile.

Two further innovations that perturbed existing systems of land warfare during the nineteenth century were the advent of the railways and the electric telegraph.[210] While not weapons themselves, these enabling technologies ensured that the weapons described above got to where they needed to be when they needed to be there and that when they arrived, the users of the weapons knew where to go and what to fire at. General staffs using the telegraph and extensive planning to coordinate troop mobilization and movement over rail systems utterly remade the logistical and command aspects of warfare, a strategic transformation demonstrated most notably by

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[207] Boot, p. 153-154.
[208] McNeill, p. 242.
[209] Boot, p. 129.
[210] One of the progenitors of the electric telegraph, the mechanically operated Chappé telegraph, had been used since the late eighteenth century to deliver military messages, but it was a costly, cumbersome and inflexible system. Widespread use of rapid communications between front and rear had to await the electric telegraph, which first appeared in the 1830s.

the performance of the Prussians under Von Moltke in 1866 against Austria and again in 1870-1871 against France. From a weapons-oriented perspective, these were ancillary activities, but were nevertheless vital in order for the concurrent developments in weaponry to realize their full potential. From this point of view, at least, the symbiosis of rail and telegraph can be thought of as part of the larger weapons systems of the rifle, the machine-gun and the Krupp artillery piece, and their diffusion acted as force multipliers to the firepower of the new weapons, a feature that might be relevant in the terrorism context. The rise of these new communications and transport technologies also meant that war now constituted a complex system whose management could no longer be undertaken by an individual commander; no matter what the degree of personal genius, all this coordination required a large general staff. Railways, especially, were large infrastructural undertakings and in most areas expanded through a combination of public investment and private capital.[211] This new channel of mobility did have one serious limitation, however. When the track ended, the army had to resort to the same plodding means of transportation it had used for thousands of years – the horse and the march on foot. Overcoming this obstacle would have to await the introduction of mechanized warfare in the twentieth century.

In the naval arena, guns and ships coevolved in a series of step-wise innovations to change the face of naval warfare profoundly. [212] Improvements in artillery and the development of exploding shells rendered wooden hulls useless in warfare, a result that was underlined by the rapid development of the self-propelled torpedo from 1866 onwards. Developed by Robert Whitehead, the range of the torpedo increased fifteen-fold and its speed more than four-fold between 1866 and 1914, and by the 1870s these weapons were being purchased by all the major naval powers.[213] These changes in the nature of warships were not smooth or comprehensive – for a long time sails and steam

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[211] For a full discussion of this public-private partnership, see Herrera and Mahnken, 'Military Diffusion', *passim*, especially pp. 221-223.

[212] For example, McNeill describes how as armour got thicker, guns had to become larger and more powerful, which in turn made it too difficult to mount them along a ship's sides. Having to position the guns on board along the centre line of the vessel meant that sails and masts could no longer be used if the guns were to have room to fire, which prompted the development of more powerful maritime steam engines, and so on (McNeill, p. 241).

[213] Boot, p. 175. In another example of naval coevolution, since torpedoes could be launched from small, fast attack boats against even the largest warships, a new class of ship emerged – the torpedo-boat destroyer – to intercept torpedo boats. These 'destroyers', as they came to be more simply known, in turn proved useful for the attack, as well as the defence, and precipitated a new set of naval tactics and operations.

power coexisted in misshapen hybrids of the old and the new.[214] However, by the turn of the twentieth century, almost all capital ships in the fleets of the naval powers were steam-powered, steel-hulled hulks bearing one or more gargantuan guns. Part of the reason was the intense technological rivalries and corresponding arms races that developed between the European powers. The pattern in the mid-late nineteenth century usually saw France develop a new naval innovation first, with the British navy responding soon afterwards to adopt a similar or offsetting innovation. In the early twentieth century, the primary rivalry for bigger and better vessels and guns was between Britain and Germany, but the dynamic was similar.

These developments were not without their complications, however. The controversial case of the British Royal Navy's rejection of the entrepreneur Arthur Pollen's fire control system in favour of the in-house Dreyer tables, whatever the true causes or consequences of that decision,[215] demonstrated that, for perhaps the first time in history, weapons systems were becoming so complex that military commanders tasked with deciding whether or not to adopt innovations might no longer have the technical knowledge or time to understand or properly evaluate them. This meant that other parties, whose interests might differ from those of the military commander, had additional space in which to influence adoption decisions – a state of affairs that has grown progressively more pronounced over the course of the past century.[216]

Many of the innovations in weaponry between the Napoleonic period and the First World War, such as breechloading guns or rifled barrels, had existed in earlier forms but could not be effectively adopted for military use before the coming of precision machining and mass production in the nineteenth century. Thus, developments in the broader economy directly affected warfare and precipitated the diffusion of new weapons. This diffusion was helped by other socio-political developments, including

[214] Part of the reason for retaining sails was that initially steam powered ship engines were somewhat unreliable and imposed a large logistic burden.
[215] Many historians have argued that the British – whether out of ignorance, vested interests or financial considerations – adopted the inferior system, which was one of the prime causes of their losses at the Battle of Jutland in 1916 (see for example McNeill, pp. 294-296). Of course, there are many other theories for the Jutland losses (Nicholas A. Lambert, ' "Our Bloody Ships" or "Our Bloody System"? Jutland and the Loss of the Battle Cruisers, 1916', *Journal of Military History*, 62:1 (Jan. 1998), pp. 29-55). For a contrary view, that the British indeed adopted the more appropriate system for their needs, see Brooks.
[216] McNeill, p. 227.

directed invention driven by governments[217] and enacted by both the military and private sectors, as well as a renewed vigour in applying the latest scientific and engineering principles to solve problems that had long bedevilled weapons performance. The appearance of innovations also accelerated, sometimes outstripping the ability of militaries and their societies to accommodate them, irrespective of cultural compatibilities.

In terms of leveraging organization and tactics to effectively exploit these technical innovations, the Prussians must rank near the top, with the French also among the earliest adopters of new weaponry, especially during the latter half of the nineteenth century. Since the failure to adopt seemed to mean quick defeat, several countries felt compelled to emulate the Prussian model and only partially succeeded, once again finding the hardware far easier to implement than the required software (modifications in doctrine and organization) that attended new weapons. The British, although by no means at the vanguard, did tend to follow closely in adopting the majority of the most important advances in weaponry during this period.[218] Thus, by the outbreak of World War I, most of the belligerents were equipped with large numbers of strikingly similar weapons, including heavy artillery, steel-hulled warships, machine guns, and so forth, and the volume of firepower they could deploy against each other was unprecedented. Furthermore, each of the major powers (except perhaps Britain) could mobilize their forces massively in short order.

While the latest weapons had been assimilated into all the modern militaries, what had not quite sunk in (except among the prescient few) was that the tremendous firepower and mobilization capacity would favour the defence over the offense. The results are familiar: a mixture of entrenchment, indirect fire, and command by wire from the rear formed the ingredients from which the morass of the Western front was concocted. Unfortunately for all concerned, doomsayers like Bloch were largely vindicated, as the *attaque à outrance* failed tragically and the conflict settled into a fetid state of attrition wherein victory would be decided by which society could manufacture the most ammunition and explosives.

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[217] McNeill, p. 331.
[218] Herrera and Mahnken, 'Military Diffusion', pp. 206; 226.

World Wars and Beyond

The 20th century witnessed a plethora of innovations – not only the pace but the breadth of new weapons development accelerated immensely. These included new weapons platforms such as the submarine and the aircraft carrier, entirely new combat arms (the strategic air force), technological breakthroughs in reconnaissance and navigation such as radar, satellites and more recently GPS, and novel tactical aids such as the Norden bomb-sight, night-vision devices and laser illuminators to direct aerial bombardment. Substantive discussion of the diffusion experience of only a select sample of these is possible here,[219] followed by a more general consideration of the nature of weapons diffusion in the twentieth century.

Armoured Mechanized Warfare

The development of the tank and attendant doctrines of mechanized warfare presents a variety of diffusion experiences. Ideas for motorized, armoured, tracked vehicles that could be used in combat had been proposed by several inventors before World War I, but none were pursued because the militaries of the day did not see any need for them. It was only when the fighting in World War I became bogged down in the trenches that concerted efforts were made, mostly in Britain,[220] to develop what became known as the tank. Yet, even with the desperate need to break the logjam at the front, the British army only tepidly embraced the tank. The early versions proved helpful (but not decisive) in overrunning enemy trenches, and even began to take on some of the traditional cavalry roles by 1918, but did not overwhelm many observers during their initial forays into battle. It was the performance of tanks at Cambrai in November 1917 that got several military observers to take notice and forward thinkers to begin to imagine a role for the tank beyond infantry support.[221]

After the War, thinking about mechanized warfare split into two camps – one which viewed tanks and similar motorized vehicles as merely an adjunct to the core fighting elements of infantry and artillery, and a vocal minority who saw in the tank a means by which warfare would be revolutionized by restoring strategic mobility to combat and

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[219] For further examples, see Murray and Millett, Goldman and Eliason, and Rosen.
[220] Indeed, it was none other than Winston Churchill, at the time an 'eccentric civilian in the British Admiralty' (Van Creveld, p. 222) who championed the production of the early tanks.
[221] Thomas Mahnken, 'Beyond Blitzkrieg', in Goldman and Eliason, p. 243.

relegating all other arms to a supporting role. Among the enthusiasts were Basil Liddell Hart and J.F.C. Fuller in Britain, Charles de Gaulle in France, Heinz Guderian in Germany, Adna R. Chaffee, Jr. in the United States and Mikhail Tukhachevsky in the Soviet Union, however each fared differently in encouraging military or political leaders to adopt the new concept of mechanized warfare. The familiar tale of the adoption of the tank can be summarized thus: only the Germans, the losers in World War I who were not even supposed to possess such weapons under the armistice agreement, wholeheartedly embraced the tank and the motorized division and centred their strategy on the new combined-arms armoured warfare concept of *blitzkrieg*, in what has been described as 'the canonical case of peacetime military innovation'.[222] The Soviets were the next most successful adopters, devising a somewhat different strategic concept of 'deep operations' and licensing tank technology to build its T-34 tank from the American inventor J. Walter Christie after the U.S. Army had rejected the same. Despite producing more tanks than anyone else, training and doctrine suffered, especially after Stalin's purges of thousands of talented military officers in the late 1930s. The United States went some way towards developing the designs for an armoured corps, but rejected or quickly disbanded any attempt to seriously implement the idea. In Britain, substantial development work took place in the interwar years, but except for the short-lived Experimental Mechanised Force in the late 1920s, tank doctrine was conservative and stressed support for the infantry. The French developed possibly the most advanced tanks, and almost as many as the Soviets, but did not succeed in integrating these into a cohesive armoured doctrine. It is worth noting that both Liddell Hart and de Gaulle, after failing to convince their military commands of the potential of armoured warfare, looked for champions in the civilian leadership of their respective war departments. Although they did find more receptive audiences there, this attempt to circumvent standard military protocols did not ingratiate them to their commanders, who in turn became even more obdurate with respect to their ideas and, arguably, left a sour taste for technical innovation in general.[223]

The astonishingly effective performance of German mechanized warfare at the beginning of World War II eliminated any reticence regarding the utility of armoured

[222] Mahnken, 'Beyond Blitzkrieg', p. 244.
[223] Rosen, p. 13.

warfare and the decisive advantages of the mobility it represented.[224] This was set in stark relief by the rapidity of the French defeat, whose army, despite having more numerous and in some ways more advanced tanks,[225] squandered any potential advantage by misapplying the new innovation of mechanized warfare, including sprinkling their armour throughout their infantry divisions,[226] rushing their best units into Belgium and keeping many of their forces in reserve until it was too late. In light of the Germans' initial success, the armies of the remaining Allies – Britain, the Soviet Union and the United States – all ramped up their production of tanks and other armour, in addition to changing their doctrine to versions of the combined-arms approach, but even then their adoption of the German model was imperfect, having to contend both with playing catch-up during a war and pockets of continued organizational-cultural resistance to the new means and methods.[227] For example, while the Germans were able to masterfully coordinate their tank assaults with two-way radios in each tank, most of the American and British tanks only had radio receivers, with much of the Soviet force without any wireless communication. So, even though many of the Allied tanks were superior in terms of firepower and armour, they could not be as effectively utilized as the German tanks. Other seemingly small details would also prove crucial – such as a more efficient interior layout within the German tanks, and the greater overall reliability of the German tank engines.[228]

Although it quickly became a key element of land warfare, the tank did not quite live up to the lofty expectations of its most ardent initial supporters. The development of anti-tank infantry weapons is one reason. Another is an aspect of mechanized warfare that proved just as critical in the Second World War as it does today – the constraint imposed by the supply train. Tanks, from the opening salvos of World War II to the Gulf Wars of 1991 and 2003, have proven able to provide far-ranging mobility that allows for an almost unstoppable forward momentum. But such momentum will be only

[224] Although the conventional wisdom for much of the past several decades has focused on the superiority of the so-called *blitzkrieg* doctrine, more recent scholarship has called into question the existence of a concerted German strategy to rapidly overwhelm Allied forces (Karl-Heinz Frieser, *The Blitzkrieg Legend: The 1940 Campaign in the West* (Annapolis, MD: US Naval Institute Press, 2005)). Whether the Germans intended a lightning campaign or a slow war of attrition, however, armour was central to their strategy.
[225] The French tanks did possess better armour and bigger guns, and in this sense were superior to their German counterparts (Dunnigan, p. 58). Yet, they suffered from other design flaws, including small fuel tanks and an internal layout that hindered their effectiveness.
[226] Hammes, p. 202.
[227] Mahnken, 'Beyond Blitzkrieg', pp. 244; 264.
[228] Dunnigan, p. 59.

transitory if fuel, spare parts and maintenance crews do not keep up with the leading edge of the mechanized spear; brief armoured forays using pre-positioned supplies that quickly subdue the enemy (like those against France in 1940 and Iraq in 1991) are therefore strikingly effective, but longer campaigns, which tax the ability of supply trains to keep up, such as the deep German attack into the Soviet Union in World War II, can blunt the advantages of mechanized armour. Armoured, mechanized warfare has continued to play a central role on the traditional battlefield right up to the present, however, with steady if not revolutionary innovations such as composite and reactive armour, computerized 'one touch' firing systems and armour-piercing depleted uranium projectiles, maintaining the tank's strategic punching power.[229]

Aircraft Carriers

One of the key decisions that faced the navies of the major powers in the interwar period was whether to adopt the aircraft carrier as a platform for exploiting air power at sea. This was not an enterprise to be embarked upon lightly – aircraft carriers would be for all involved the most expensive piece of naval equipment yet conceived of. There were strong strategic reasons for several of the major powers of the time (Italy, Britain, the United States and Japan) to invest in the aircraft carrier, while for others (Germany and the Soviet Union) this was (initially at least) a matter of prestige and declaring equal status as a Great Power, serving much the same function as the capital ships of half a century earlier. Yet, as with so many other weapons systems, adoption was not purely a rational response to needs. The British could have used carriers to cement their naval supremacy in the Mediterranean and the Italians to challenge the British there. Yet the British deployed their carriers defensively, subordinate to their traditional naval strategies, while the Italians believed land-based aircraft would suffice, the result being that neither country adapted aircraft carriers for offensive purposes, at least not until very late in the war. Similarly, Germany initially viewed naval air power as useful mainly for reconnaissance, coastal patrol and escort and only belatedly came around to viewing carriers as means to push the strategic offensive.[230]

Even the United States and Japan, who understood the power-projection capabilities of

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[229] Boot observes that during the Second World War, the average number of shots needed by one tank to kill an enemy tank was seventeen; by the 1991 Gulf War it was close to one (Boot, pp. 329-330).
[230] Goldman, 'Receptivity to Revolution', p. 276.

the carrier group and overcame orthodoxy to make naval air power the centre of their maritime strategies, both experienced setbacks in the adoption process. On the American side, even after Pearl Harbour, the proponents of decisive sea battles between large battleships retained influence, subordinating the air arm to traditional naval concerns until late in the war. The Japanese navy, for its part, became embroiled in a bureaucratic tug-of-war with its army over priorities for its aircraft.[231] Furthermore, only the United States actually possessed the resources and productive capacity to sustain several large carrier groups over an extended period in the face of battle losses. One noteworthy aspect of the diffusion of aircraft carriers in the Second World War is that late in the war, the British operated closely with the Americans in the Pacific, allowing for the rapid dissemination of U.S. carrier doctrine and technologies to the British,[232] possibly indicating the role that close cooperation with allies can have in facilitating successful diffusion of weapons innovations.[233]

Nuclear Weapons

The question of whether nuclear weapons are singular devices in the annals of weaponry[234] and the extent to which they have impacted the nature of war, strategy, the conduct of international politics and even the future of the human species, is a matter of much debate.[235] The focus here, however, is on the historical experience of the diffusion of nuclear weapons at the state level. In terms of their origin as an innovation, Colin Gray makes a strong case for nuclear weapons being largely the product of technological determinism. This line of argument proceeds that, although the timing may have been accelerated by the glaring focus of the Manhattan Project, scientific understanding of the physics of the atom had reached a critical point in the early twentieth century, to the extent that even the fertile imaginations of science fiction writers foresaw the military exploitation of the awesome energies lurking deep within matter.[236] When combined with the increasing mechanization of combat from the First World War onwards and the trajectory towards unrestricted conflict – the erosion of the

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[231] Goldman, 'Receptivity to Revolution', p. 301.
[232] Ibid.
[233] The British had also helped the Japanese develop their carrier force in the 1920s and 1930s.
[234] Colin Gray convincingly makes a case for the uniqueness of nuclear weapons thus: 'Special respect is due a weapon that can trump all other weapons, that in effect could knock over the game table cancelling the value of all other pieces on the board and all points scored to date' (Gray, pp. 42-43).
[235] Van Creveld, pp. 252-253; Buzan pp. 31-32; Lawrence Freedman, *The Evolution of Nuclear Strategy* (London: St. Mertin's Press, 1989).
[236] H.G. Wells, *The World Set Free* (Hollywood: Leisure Books Inc, 1971 [1914]).

line between front and rear, solider and civilian – Gray paints the invention of nuclear weapons as all but inevitable.[237]

As for the genesis of nuclear weapons, in one of the few clear-cut cases of non-military scientists perceiving the military ramifications of new knowledge, it was physicists Leo Szilard and Albert Einstein who brought the terrifying possibility of the atomic bomb to political and military leaders and urged its development as a strategic necessity in the face of a possible German bomb. Moreover, unlike many weapons innovations, the advent of nuclear weapons was driven by and took place almost exclusively during a period of war, rather than as a response to a previous conflict or in preparation for a potential conflict to come. In any event, the drama surrounding the development of the first nuclear weapons and their subsequent deployment against the Japanese has been eloquently told[238] and it is enough to state the obvious, that every military-minded person on the planet became abruptly aware of the significance of the atomic bomb in August 1945.[239] The relevant questions then became: who would emulate the United States in adopting these weapons and why, or perhaps more tellingly, why not?

After 1945, and even more so with the rise of thermonuclear weapons in the 1950s, the stakes surrounding these terrible weapons were such that no major power (or would-be major power) could afford to ignore a decision on the nuclear option. Predictably, the United States' incipient rival, the Soviet Union, immediately concentrated a significant portion of its meagre post-war resources on developing their own weapon, something they succeeded in doing in 1949.[240] By the early 1970s, the USSR possessed more warheads than the United States and the bi-polar Cold War system had settled under the shadow of 'mutually assured destruction' (MAD). Yet in what retrospectively seems a rather ill-considered move, both the United States and the Soviet Union in the 1950s actually facilitated the transfer of nuclear know-how not only to their immediate allies,

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[237] Gray, pp. 226-231.
[238] Lillian Hoddeson, Paul W. Henriksen, Roger A. Meade and Catherine Westfall, *Critical Assembly: A Technical History of Los Alamos During the Oppenheimer Year, 1943-1945* (Cambridge, MA: Cambridge University Press, 1993) and Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon and Schuster, 1986).
[239] The gravity of nuclear weapons and the discontinuity in the evolution of weaponry that they represented was lost on no leader of any sensibility. Winston Churchill, who found out about the atomic age a little earlier than most after the Trinity test in New Mexico on 16 July 1945, exclaimed: 'What was gunpowder? Trivial. What was electricity? Meaningless. This Atomic Bomb is the Second Coming in Wrath!' (cited in Freedman, p. 16).
[240] Possibly the best account of the Soviet bomb development program is David Holloway, *Stalin and the Bomb: The Soviet Union and Atomic* Energy, 1939-1956 (New Haven, CT: Yale University Press, 1996).

but to several other states within their hoped-for sphere of influence. For example, the American 'Atoms for Peace' initiative explicitly sought to spread nuclear expertise, ostensibly only for peaceful purposes like research and power generation, but which consequently served as the kernel for weapons programs in several countries. Many countries were content to forego the development of nuclear arms in exchange for security guarantees; others, for a variety of reasons, were not.

William Potter traces the array of possible motivations why a state might seek nuclear weapons, divided into sets of incentives, disincentives and situational, or so-called 'trigger', events.[241] Incentives include deterrence of adversaries, a military advantage if war erupts, coercion of opponents, the result of being an international pariah, a quest for status and prestige, domestic bureaucratic interests aiming to benefit from a weapons program and, finally, technological incrementalism, wherein a weapons capability is attained without a preconceived plan.[242] Disincentives for producing nuclear weapons can include cost, international opprobrium and sanctions, upsetting the balance of power and destabilizing the regional or global system, and domestic or bureaucratic opposition.[243] Scholars have also put forward a number of trigger events that might shift a state's cost-benefit calculus so that acquiring nuclear weapons becomes favoured, or vice versa. These can include the nuclearization of a neighbour or close rival (the domino theory of proliferation), increased accessibility of material and know-how, domestic crises that encourage leaders to divert attention outwards, and a variety of looming deadlines for a state, such as an election, or a treaty coming into force.[244]

After an analysis of the decisions of twenty-six states to acquire, forego or renounce nuclear weapons, Potter concludes that there is no typical profile of underlying factors – varying country-specific incentives, constraints and trigger events combine in each case to yield a final decision whether or not to produce nuclear weapons and how many and of what type to produce.[245]

The British tested a nuclear weapon in 1952 and the French in 1960. After the Chinese

[241] William Potter, 'The Diffusion of Nuclear Weapons', in Goldman and Eliason, *passim*.
[242] Potter, pp. 151-158.
[243] Potter, pp. 159-160, p.167.
[244] Potter, pp. 161.
[245] Potter, p.166. Potter claims that this finding flies in the face of the conventional wisdom held by most U.S. policymakers over the years that states only seek to develop nuclear weapons when they perceive a military threat that cannot be assuaged through alternative means.

tested their first atomic bomb in 1964, the leading powers feared a rapid destabilization of the international system should dozens of states acquire nuclear weapons and decided to attempt to prevent any more states from acquiring these weapons. To accomplish this, they created a nonproliferation regime with the Treaty on the Non-proliferation of Nuclear Weapons (NPT) as its centrepiece. Imperfect as this regime is, it placed controls on the materials and technology required to produce nuclear weapons and represented one of the first concerted and sustained global efforts to prevent the diffusion of a new weapons system to most of the world's nations.[246] Yet some states, namely Israel, India, South Africa, Pakistan and North Korea, stayed outside or defected from the regime and successfully pursued nuclear weapons over the following decades. Other states flirted with development programs but chose to abandon them.[247] In all these cases, the development of nuclear weapons has involved a significant devotion of state resources, and prolonged endorsement by military and political leaders. The nuclear nonproliferation regime is currently under strain, primarily from defectors such as North Korea and Iran, but also because the existing nuclear powers have failed to hold up their end of the nuclear grand bargain and work towards complete disarmament. From a historical point of view it is worth noting here that nuclear weapons, with their sobering power to end all human life, have dominated strategic discourse for over sixty years, despite not having killed a single person since Hiroshima and Nagasaki.

Guided Projectile Weapons

The technologies that allowed for extended human control of projectile weapons at various stages of their flight paths encapsulate several features of weapons diffusion and thus provide a good example of 20th century advanced technology diffusion. Guided weapons were developed out of a need to address the inaccuracy of standard bombs when dropped from airplanes, as it was far more difficult to establish reliable ballistic trajectories than was the case with artillery. The first guided, as opposed to aimed, munitions made their debut in 1942, with the German Fritz-X guided bombs whose flight paths could be modified to some extent by radio control. This prompted the expected mirror response by the Allies, who developed the AZON, RAZON and TARZON guided bombs. Miniaturization of electronic components led to the

[246] Previous arms control agreements were either stillborn (e.g. the Pope's purported banning of crossbow use against Christians) or sought only to limit the number of arms (e.g. the Washington Naval Treaty of 1922).
[247] Examples include South Korea, Libya, and Argentina.

deployment of the Walleye EOGB (Electro-optical Glide Bomb) in 1962, which utilized television cameras to home in on its targets,[248] followed by laser-guided bombs used from the later stages of the Vietnam War onwards. Guided weapons are thus another example of novel high-technology weapons systems that initially did not perform to expectations, but consistently improved to the point where 'take-off' could occur and they would become indispensable weapons on the modern battlefield.

The development of the ballistic missile can be traced back to Chinese fireworks through to the Congreve rockets of the nineteenth century, but the first use of large-scale missiles occurred following the German development of the V-2 during the Second World War. This has been described as representing a military takeover of what was essentially a civilian invention up to that time,[249] but it can also be argued to constitute an example of the folly of vacillation in adopting an innovation. Ernest Volkman argues that it was Hitler's dithering regarding full endorsement of the V-2 until 1943 which delayed its deployment until 1944, too late to have any militarily significant impact on the war,[250] although there continues to be debate over whether the technology would have been ready until 1944 regardless. In any event, the weapon's potential had been appreciated since the Allies had first learned of the weapon from the famous 'Oslo Report' in 1939.

In the post-war environment, the U.S. is argued to have 'hedged' its weapons innovation program; in order to account for the abundant uncertainties with the new weapon, the U.S. pursued multiple research efforts to the point of procurement but no further, rather than fully implementing any specific weapons.[251] This weapons development strategy seems to have paid off when, a few years later, the invention of the hydrogen bomb enabled lighter warheads, thereby making intercontinental ballistic missile delivery vehicles a feasible option for part of the nation's strategic nuclear deterrent.[252] Ballistic missiles have since become one of the most sought-after pieces of military technology, proving to be within the capabilities of several states outside of the major powers and leading to separate attempts at arms control. For example, in the case of Iraq, Saddam

[248] Dunnigan, pp. 126-129.
[249] Van Creveld, p. 221.
[250] Volkman, p. 174.
[251] Rosen, pp. 245-247.
[252] Indeed, Rosen (p. 248) has argued that, 'It was not a Soviet threat, or a civilian scientific intervention in the context of fixed technological possibilities that pushed the innovation of the ICBM, but a new and unforeseen technological innovation created by civilian physicists'.

Hussein purchased the basic Soviet missile technology and then proceeded to successfully retrofit and adapt these missiles to perform new, expanded missions that met his requirements in both the Iran-Iraq and first Gulf Wars.[253] Such occurrences no doubt encouraged many other actors, who have embarked upon similar large-scale indigenous weapons development programs, including North Korea and Iran.

In terms of air-to-air missiles, the first success actually emerged from a secret, unauthorized development project undertaken by maverick U.S. navy weapons engineers in 1953 to produce the AIM-9 sidewinder heat-seeking missile.[254] This is yet another illustration in a long line of historical examples, that under certain conditions, a small group of resourceful and committed actors can produce a significant weapons innovation. Another set of cases where an actor outside the official military structure of a great power innovated to produce an asymmetric weapon can be found in the Israeli weapons development experience. Hoyt describes the production of several weapons and weapon systems, including the Gabriel ship-to-ship missile and the first unmanned aerial vehicles (UAVs), which the Israelis succeeded in developing more rapidly and inexpensively than the major powers. In fact, several of these weapons systems then diffused to both superpowers and other periphery states, such as India.[255]

Guided projectile weapons also serve as an example of an instance where increasing complexity in electronics and materials made the weapons more reliable and efficacious, rather than less, which cannot be said for all weapons systems. The remarkable growth in the performance of guided munitions can be summed up by comparing bombing efficiencies: during World War II, it took B-17 bombers flying 4,500 sorties and dropping 9,000 bombs to have the same effect that today can be attained by a single F-117 on a single sortie dropping a single guided bomb.[256]

Major Features of 20th Century Weapons Innovation and Diffusion

As the pace of scientific advancement quickened, the military history of the twentieth century became more inextricably linked than any previous period with quests to create

[253] By piecing together parts from multiple missiles in Frankenstein fashion, the Iraqis managed to vastly extend the range and payload of the Scud missile.
[254] Dunnigan, p. 170.
[255] See Hoyt, pp. 183-188.
[256] Toffler and Toffler, p. 92.

and adopt ever more complex and destructive technologies. Unlike past demagogues like Napoleon or Alexander, many of the more insatiable and warmongering autocrats of the twentieth century, men such as Hitler or Saddam Hussein, became obsessed by military technologies and seduced by the siren songs of weapons that they believed could give substance to their delusions of power and domination. They were not the only ones – whether out of a sense of self-preservation or creative industry, most of the world's military and political leaders eventually came around to a way of thinking that equated technological prowess with military success and national security. This shift in emphasis away from tactics and esprit and towards the technical was not always explicit or planned, nor was it always warranted. Nonetheless, in the behaviour of the world's militaries, even if only intermittently in their stated objectives, the perception of the criticality of technology prevailed.[257]

One consequence of this was the elevation in the military regard for the scientist, who quickly became as much an element of military thinking as any field commander or operational terrain. Since scientists would continue to discover and invent and technology would therefore invariably advance, military planners were driven by a 'technological imperative'[258] to institutionalize or otherwise manage technological change. In the case of weapons, one option was to systematically import novel weapons systems in order to maintain parity with competitors. Where this was impossible, or where resources permitted, the second option was to steer the latest scientific developments in one's own country towards exploitation by the military, as, for example, intended by the American Office of Scientific Research and Development during the Second World War, or the Defense Advanced Research Projects Agency today. This long-term merging of the military and scientific establishments, while by no means historically unique, was unprecedented in scale and has been argued to have been more efficacious in terms of weapons innovation than either the military or scientists working alone.[259] For example, the Allies in World War II are described as having benefited tremendously from 'a centralized scientific research and development apparatus that could react quickly to any new threat, redirecting resources to come up

[257] Although it is debatable whether it would ultimately have been effective, the initiation of the 'Assault Breaker' program by NATO during the Cold War had a tremendously unsettling effect on Soviet military planners, because they believed that NATO technological advances in computing and miniaturization would be able to offset the conventional military superiority of Warsaw Pact forces in Europe (Gray, pp. 247-248).
[258] Buzan, p. 110.
[259] Rosen, pp. 249-250

with a counter'[260] in that any emerging German technical advantage was quickly blunted. This trend is demonstrated perhaps most vividly with Operation Paperclip and equivalent initiatives, where the victorious powers scrambled to locate and recruit Nazi and Japanese scientists after World War II, who were spared the punitive measures meted out to their less technically-proficient compatriots.

Moreover, the perception that conflicts could be won and lost by the creation of a decisive new weapon, a secret *enfant terrible* that might emerge in the hands of the enemy to turn the tide in his favour, meant that governments devoted ever greater shares of their national resources to military research and development. It also meant that any major weapons innovations were emulated far more rapidly than before, especially during times of war.[261] Some have argued that this in turn led to an isolated institutionalization of weapons innovation, where 'technological innovation [became] largely unaffected by the activities of potential enemies, a rather self-contained process in which actions and actors within the military establishment were the main determinants of innovation'.[262] In a dangerous inversion of Clausewitz's primary dictum, policy could thus come to serve war[263] – or, more precisely, the threat of war, a condition excoriated by opponents of the so-called 'military-industrial complex'. Whatever the veracity of such depictions – the reality probably lies somewhere between an exaggerated conspiracy and a completely sanguine civil-military partnership – a convincing case can be made that the first four decades of the twentieth century witnessed continual increases in the overall level of destructiveness with no insurmountable or persistent advantage accruing to any single actor. The inevitable result of this technological treadmill, one may argue, was the ultimate technological stalemate of MAD and mostly futile efforts ever since to step down from the precipice of nuclear Armageddon.

In terms of the diffusion process itself, the twentieth century brought to light several dynamics that had not been seen previously or had merely been hinted at in previous

[260] Volkman provides a convincing list of such technological 'counterpunches' (Volkman, p. 174).
[261] Indeed, Dunnigan (p. 17) credits the intense conflicts of the twentieth century (especially the two World Wars and the rivalries of the Cold War) as being responsible for the accelerated pace of weapons development in the twentieth century, with a decade to decade increase in development tempo.
[262] Rosen, p. 250.
[263] Van Creveld points towards Ballistic Missile Defence as a recent example of an innovation that was 'driven less by any clear idea as to [its] usefulness or even desirability than by the foibles of the powers that be' (Van Creveld, p. 260).

centuries. One of these is the role of champions within military structures that can sometimes override bureaucratic inertia or institutional resistance to adoption of a new weapon. Pierce argues that in the case of disruptive innovations, these champions may even have to disguise their work with a new weapon by portraying the innovation as an incremental advance and cites the example of Admiral Moffett and carrier warfare.[264] Another dynamic is the diffusion of weapons to allies. In some cases this occurs in a surprisingly unimpeded and, some might say, even hasty manner, two examples being the exclusive relationship between the United States, Britain, Australia and Canada, who 'allow an all but free flow of information of military technical and organizational innovations'[265] even when mutual perceptions of threat are absent, and when NATO members make familiar, accessible or politically expedient weapons adoption decisions even when certain systems are not the most effective.[266] Soviet weapons diffusion to the Warsaw Pact demonstrated the converse approach with similar effects – there the coercive dissemination of innovations to its allies was driven by the political desires of the patron rather than the military needs of the client, thus resulting in weapons that were often ill-suited to the social, political and cultural contexts of the adopters.[267]

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[264] Terry Pierce, *Warfighting and Disruptive Technologies: Disguising Innovation* (New York: Routledge, 2004), p. 183.
[265] Thomas-Durell Young, 'Cooperative Diffusion', in Goldman and Eliason, p. 111, 113.
[266] Goldman and Ross, p. 377.
[267] Jones, p. 117.

Appendix B: Case Study Tables

Notes: For all of the tables below, space constraints necessitate abbreviating the variable names; for the full descriptions, see Table 4.1. The first time the value for a variable is presented for a particular organization, a justification for the selection of that value and appropriate citations are given in an attached endnote, unless the value is obvious from the case study. The '+' or '–' signs in parentheses denote the degree to which the variable is judged to affect the overall outcome, as described in Chapter 4 (with '.' denoting no effect). Also, as detailed in Chapter 4, the totals in each column are derived by a simple algebraic sum of the scores for individual variables. Under the 'Support Hypothesis' column, 'S' denotes 'supports hypothesis', 'U' denotes 'undermines hypothesis' and '-' denotes 'neither supports nor undermines hypothesis'. In Tables B.4 to B.6, the 'C' in the 'Support Hypothesis' columns refers to cyanide, while the 'R' refers to rockets.

Table B.1.: PIRA-INLA Weapon Awareness Sub-Model

	PIRA [Was Aware of Mortars]		INLA [Was Aware of Mortars]	
	Phase I (1969-1971)		**Phase I (1974-1985)**	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?
SOCIETY				
Infrastructure	Developed[1] (++)	S	Developed (++)	S
Social/Political Openness	Yes[2] (++)	S	Yes[3] (++)	S
Security Pressure	Yes[4] (+)	S	Yes[5] (.)	S
PRIOR ADOPTION				
Networked (General)	Highly[6] (+)	S	Low[7] (.)	-
Networked (VNSAs)	Low[8] (.)	-	High[9] (++)	S
Demonstration (1st)	Unknown[10] (.)	-	Yes[11] (++)	S
Proselytization	No (.)[12]	-	No[13] (.)	-
State Sponsorship	Medium (.)	-	No (.)	-
Serendipitous Acq.	No[14] (.)	-	No (.)	-
ORGANIZATIONAL CHARACTERISTICS				
Demonstration (2nd)	Yes (+)[15]	S	Yes (+)	S

# of Successful prior adopters	None[16] (-)	U	1[17] (+)	S
Prior Autarkic Adoption	No[18] (.)	-	Yes[19] (+)	S
Size	Large[20] (+)	S	Medium[21] (.)	-
Talent pool size	?[22] (.)	-	Small[23] (.)	-
Centralization	Mixed[24] (++)	S	Centralized[25] (.)	-
Learning Org.	Yes[26] (++)	S	No[27] (.)	-
Skunkworks	Yes[28] (+++)	S	No (.)	-
Techne Org.	Medium[29] (.)	-	High[30] (+)	S
Mētis Org.	Low[31] (.)	-	High[32] (+)	S
Safe Haven	Yes[33] (+)	S	Yes[34] (+)	
Access to Training Programmes	?[35] (.)	-	Yes[36] (++)	S
Resource Surfeit	No[37] (.)	-	No[38] (.)	-
Cognitive Biases	In favour[39] (.)	-	Against[40] (-)	U
Follow-the-leader Bias	No[41] (.)	-	No[42] (.)	-
Attitude towards Innovation	In favour[43] (+)	S	In favour [44] (+)	S
Affinity for weapon / technology	No (.)	-	No (.)	-
Ideological / Cultural Compatibility	Unknown[45] (.)	-	?[46] (.)	-
Perceived Urgency	Yes[47](.)	U	No[48] (.)	-
Guardians of SQ	Yes[49] (-)	U	No[50] (.)	S
Active Searching	Yes (++)[51]	S	Yes[52] (++)	S
Strategic Compatibility	High[53] (+)	S	High[54] (+)	S
WEAPON CHARACTERISTICS				
Information (entire technology)	Medium[55] (.)	-	Medium (.)	-
Techne Weapon	High[56] (-)	U	High (-)	U
Commercialized Tech.	Yes [Limited][57] (+)	S	Yes [Limited] (+)	S
Observability	High (++)	S	High (++)	S
Environmental Persistence	Low (.)	-	Low (.)	-
Active Opp. of Possessors	Partial[58] (.)	-	Partial (.)	-
TOTAL AWARENESS SCORE	**+23-3 = +20**		**+23-2=+21**	

Table B.2.: PIRA-INLA Adoption Decision Sub-Model

	PIRA [Decided to Adopt Mortars]								INLA [Did NOT Decide to Adopt Mortars]			
	Phase I (1969-1971)		**Phase II (1972-1974)**		**Phase III (1975-1987)**		**Phase IV (1988-1998)**		**Phase I (1974-1985)**		**Phase II (1986-1998)**	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?
SOCIETY												
Infrastructure	Developed (+)	S	Developed (+)	S	Developed (+)	S	Developed (+)	S	Developed (+)	U	Developed (+)	U
Security Pressure	Yes (-)	U	Yes[59] (-)	U	Yes (-)	U	Yes (-)	U	Yes (-)	S	Yes (-)	S
SOCIAL NETWORKS												
Demonstration (1st)	Unknown (.)	S	Yes[60] (++)	S	Yes (++)	S	Yes (++)	S	Yes (++)	U	Yes (++)	U
Cultural Affinity (Homophily)	No[61] (.)	-	No (.)	-	No[62] (.)	-	No (.)	-	Yes[63] (++)	-	Yes (++)	-
Proselytization	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-
Serendipitous Acq.	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-
Intergroup Competition	Yes[64] (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes[65] (++)	U	No[66] (.)	-
PRIOR ADOPTION												
Demonstration (2nd)	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	U	Yes (+)	U
#of Successful Prior Adopters	None (.)	-	None (.)	-	None (.)	-	None (.)	-	1 (++)	U	1 (++)	U
ORGANIZATION CHARACTERISTICS												
Prior Autarkic Adoption	No (.)	-	Yes[67] (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	U	Yes (+)	U
Prior technology adoption outcomes (linear)	None (.)	-	Moderately successful (.)	-	Successful[68] (+)	S	Successful (+)	S	None (.)	-	Successful[69] (+)	U
Size	Large (+)	S	Large (+)	S	Large (+)	S	Large (+)	S	Medium (.)	-	Small[70] (-)	S
Talent Pool Size	Unknown (.)	-	Large (+)	S	Large (+)	S	Large (+)	S	Small (-)	S	Small (-)	S
Centralization	Moderate (.)	-	Moderate[71] (.)	-	Low[72] (+)	S	Low (+)	S	Moderate (.)	-	Low[73] (+)	U
Learning Org.	Yes (+)	S	Yes[74] (+)	S	Yes (+)	S	Yes (+)	S	No (.)	-	No (.)	-
Skunkworks	Yes (++)	S	Yes (++)	S	Yes (++)	S	Yes (++)	S	No (.)	-	No (.)	-
Cohesiveness	High (++)	S	High (++)	S	Medium[75] (.)	-	Medium[76] (.)	-	Medium[77] (.)	-	Low[78] (---)	S
Techne Org.	Medium (.)	-	High[79] (++)	S	High (++)	S	High (++)	S	High (++)	U	Medium[80] (.)	-

Mētis Org.	Medium (.)	-	High[81] (+++)	S	High (+++)	S	High (+++)	S	Medium (.)	-	Low[82] (--)	S
KT Ratio (org)	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	High (.)	-
Safe Haven	Yes (+)	S	Yes[83] (+)	S	Yes (+)	S	Unknown (.)	-	Yes (+)	U	Unknown[84] (.)	-
Resource Surfeit	No (.)	-	No (.)	-	No[85] (.)	-	No[86] (.)	-	No (.)	-	No (.)	-
Access to Training Programmes	Yes (+)	S	Yes[87] (+)	S	Yes (+)	S	Unknown (.)	-	Yes (+)	U	Unknown[88] (.)	-
Cognitive Biases	In favour (+)	S	In favour (+)	S	Unknown (.)	-	Unknown (.)	-	Against (-)	S	Against[89] (--)	S
Follow-the-leader Bias	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No[90] (.)	-
Attitude Towards Innovation	In favour (++)	S	In favour (++)	S	In favour[91] (++)	S	In favour (++)	S	In favour (++)	U	Unknown[92] (.)	-
Affinity for Weapon / Technology	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-
Ideological Compatibility	Unknown[93] (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-
Perceived Urgency	Yes (-)	U	No[94] (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	-
Champion in Leadership	Unknown[95] (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	No[96] (.)	-	No (.)	-
Veto Players	No[97] (.)	-	No (.)	-	No (.)	-	No (.)	-	Partial[98] (.)	-	No[99] (.)	-
Guardians of SQ	Yes (-)	U	Yes[100] (-)	U	No[101] (.)	-	No (.)	-	No (.)	-	No[102] (.)	-
# of Weapons Needed / Desired	Multiple[103] (-)	U	Multiple (-)	U	Multiple (-)	U	Multiple (-)	U	Multiple[104] (-)	S	Unknown (.)	-
Risk Tolerance	High[105] (+)	S	High (+)	S	High[106] (+)	S	High (+)	S	High[107] (+)	U	High[108] (+)	U
Active Searching	Yes (++)	S	Yes[109] (++)	S	Yes[110] (++)	S	Yes[111] (+)	S	Yes (+)	U	Yes[112] (+)	U
Need to Overcome Countermeasures	Yes[113] (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)[114]	U	No[115] (.)	-
Need to Overcome Desensitized Public	No (.)	-	No (.)	-	Yes[116] (+)	S	Yes (+)	S	No[117] (.)	-	Yes[118] (+)	U
Perceived Advantages of Technology	High (++)	S	High (++)	S	Unknown[119] (.)	-	Unknown (.)	-	Unknown[120] (.)	-	Unknown (.)	-
Strategic compatibility	High (.)	-	High (.)	-	High (.)	-	High (.)	-	High (.)	-	High (.)	-
Perception of ease of acq./feasibility	Unknown[121] (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown[122] (.)	-	Unknown (.)	-
WEAPON CHARACTERISTICS												
Information (Entire Tech.)	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-

Techne Weapon	High (-)	U	High (-)	U	High (-)	U	High (-)	U	High (-)	S	High (-)	S
Mētis Weapon	High[123] (-)	U	High (-)	U	High (-)	U	High (-)	U	High (-)	S	High (-)	S
KT Ratio (weapon)	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-
Commercialized Technology	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	S
Financial Cost (acquisition)	Moderate-High (--)	U	Moderate-High (--)	U	Moderate-High (--)	U	Moderate-High (--)	U	Moderate-High (--)	S	Moderate-High (--)	S
Economies of Scale	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	U	Yes (+)	U
Trialability	Moderate[124] (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-
Observability	High (+)	S	High (+)	S	High (+)	S	High (+)	S	High (+)	U	High (+)	U
Stability	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-
Life Span	High (+)	S	High (+)	S	High (+)	S	High (+)	S	High (+)	U	High (+)	U
Env. Persistence	Low (.)	-	Low (.)	-	Low (.)	-	Low (.)	-	Low (.)	-	Low (.)	-
Active Opp. of Possessors	Partial (.)	-	Partial (.)	-	Partial (.)	-	Partial (.)	-	Partial (.)	-	Partial (.)	-
TOTAL DECISION SCORE	**+24-8=+16**		**+33-7=+26**		**+31-6=+25**		**+28-6= +22**		**+24-8=+16**		**+18-14= +4**	

Table B.3.: PIRA-INLA Adoption Success Sub-Model

	PIRA [Were Successful]								INLA [Did NOT Attempt]			
	Phase I (1969-1971)		Phase II (1972-1974)		Phase III (1975-1987)		Phase IV (1988-1998)		Phase I (1974-1985)		Phase II (1986-1998)	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?
SOCIETY												
Infrastructure	Developed (+)	U	Developed (+)	S	Developed (+)	S	Developed (+)	S	Developed (+)	N/A	Developed (+)	N/A
Social/Political Openness	Yes (.)	-	Yes (.)	-	Yes (.)	-	Yes (.)	-	Yes (.)	N/A	Yes (.)	N/A
Security Pressure	Yes (--)	S	Yes (--)	U	Yes (--)	U	Yes (--)	U	Yes (- -)	N/A	Yes (- -)	N/A
SOCIAL NETWORKS												
Networked (Genl)	High (+)	U	High (+)	S	High (+)	S	High (+)	S	Low (.)	N/A	Low (.)	N/A
Networked (VNSA)	Low (.)	-	High (++)	S	High (++)	S	Medium (+)	S	High (++)	N/A	Medium (+)[125]	N/A
Demonstration (1st)	Unknown (.)	-	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	N/A	Yes (+)	N/A
Cultural Affinity (Homophily)	No (.)	-	No (.)	-	No (.)	-	No (.)	-	Yes (+)	N/A	Yes (+)	N/A
Proselytization	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
State sponsorship	Medium (+)[126]	U	High (++)	S	High (++)	S	Unknown (.)	-	No (.)	N/A	No[127] (.)	N/A
Serendipitous Acq.	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
PRIOR ADOPTION												
# of Successful Prior Adopters	None (.)	-	None (.)	-	None (.)	-	None (.)	-	1 (+)	N/A	1 (+)	N/A
ORGANIZATION CHARACTERISTICS												
Age of Group	0-2 (.)	-	3-5 (.)	-	6-18 (+)	S	19-29 (+)	S	0-12 (.)	N/A	13-25 (+)	N/A
Prior Autarkic Adoption	No (.)	-	Yes (+)	S	Yes (+)	S	Yes (+)	S	Yes (+)	N/A	Yes (+)	N/A
Prior Technology Adoption Outcomes	None (.)	-	Moderately successful (.)	-	Successful (+)	S	Successful (+)	S	None (.)	N/A	Successful (.)[128]	N/A
Size	Large (+)	U	Large (+)	S	Large (+)	S	Large (+)	S	Medium (.)	N/A	Small (.)	N/A
Talent Pool Size	Unknown (.)	-	Large (+)	S	Large (+)	S	Large (+)	S	Small (-)	N/A	Small (-)	N/A
Centralization	Moderate (+)	U	Moderate (+)	S	Low (.)	-	Low (.)	-	Moderate (+)	N/A	Low (.)	N/A

Spatial Proximity	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Low[129] (.)	N/A	Low (.)	N/A
Learning Organization	Yes (++)	U	Yes (++)	S	Yes (++)	S	Yes (++)	S	No (.)	N/A	No (.)	N/A
Skunkworks	Yes (++)	U	Yes (++)	S	Yes (++)	S	Yes (++)	S	No (.)	N/A	No (.)	N/A
Cohesiveness	High (+)	U	High (+)	S	Medium (.)	-	Medium (.)	-	Medium (.)	N/A	Low (- -)	N/A
Techne Org.	Medium (.)	-	High (++)	S	High (++)	S	High (++)	S	High (+ +)	N/A	Medium (.)	N/A
Mētis Org.	Medium (.)	-	High (++)	S	High (++)	S	High (++)	S	Medium (.)	N/A	Low (-)	N/A
KT Ratio (organization)	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium	N/A	High	N/A
Safe Haven	Yes (+)	U	Yes (+)	S	Yes (+)	S	Unknown (.)	-	Yes (+)	N/A	Unknown (.)	N/A
Resource Surfeit	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
Access to Training Programmes	Yes (+)	U	Yes (+)	S	Yes (+)	S	Unknown (.)	-	Yes (+)	N/A	Unknown (.)	N/A
Cognitive Biases	N/A (.)	-	N/A (.)	-	Unknown (.)	-	Unknown (.)	-	Against (-)	N/A	Against (-)[130]	N/A
Follow-the-leader Bias	No (.)	-	No (.)	-	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
Ideological Compatibility	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	N/A	Unknown (.)	N/A
Perceived Urgency	Yes (-)	S	No (.)	-	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
Champion in Leadership	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	No (.)	N/A	No (.)	N/A
Veto Players	No (.)	-	No (.)	-	No (.)	-	No (.)	-	Partial (.)	N/A	No (.)	N/A
Guardians of SQ	Yes (-)	S	Yes (-)	U	No (.)	-	No (.)	-	No (.)	N/A	No (.)	N/A
# of Weapons Needed / Desired	Multiple (-)	S	Multiple (-)	U	Multiple (-)	U	Multiple (-)	U	Multiple (-)	N/A	Unknown (.)	N/A
Determination	High (++)	U	High (++)	S	High (++)	S	Medium (+)	S	High[131] (++)	N/A	Low-Medium (.)	N/A
Strategic Compatibility	High (+)	U	High (+)	S	High (+)	S	High (+)	S	High (+)	N/A	High (+)	N/A
WEAPON CHARACTERISTICS												
Information (entire tech.)	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	-	Medium (.)	N/A	Medium (.)	N/A
Techne Weapon	High (-)	S	High (-)	U	High (-)	U	High (-)	U	High (-)	N/A	High (-)	N/A
Mētis Weapon	High (--)	S	High (--)	U	High (--)	U	High (--)	U	High (- -)	N/A	High (- -)	N/A

Ease of Acquisition	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	-	Unknown (.)	N/A	Unknown (.)	N/A
Commercialized Tech.	Yes [Limited] (+)[132]	U	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	S	Yes [Limited] (+)	N/A	Yes [Limited] (+)	N/A
Financial Cost	Moderate-High (.)	-	Moderate-High (.)	-	Moderate-High (.)	-	Moderate-High (.)	-	Moderate-High (.)	N/A	Moderate-High (.)	N/A
Technology Maturity	Late (+)	U	Late (+)	S	Late (+)	S	Late (+)	S	Late (+)	N/A	Late (+)	N/A
Trialability	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	-	Moderate (.)	N/A	Moderate (.)	N/A
Observability	High (+)	U	High (+)	S	High (+)	S	High (+)	S	High (+)	N/A	High (+)	N/A
Stability	High (+)	U	High (+)	S	High (+)	S	High (+)	S	High (+)	N/A	High (+)	N/A
Active Opp. of Possessors	Partial (-)	S	Partial (-)	U	Partial (-)	U	Partial (-)	U	Partial (-)	N/A	Partial (-)	N/A
TOTAL SUCCESS SCORE	**+18-9=+9**		**+28-8=+20**		**+29-7=+22**		**+23-7=+16**		**+19-9=(10)**		**+12-11=(1)**	

Table B.4.: CSA-Order Weapons Awareness Sub-Model

	CSA [Was NOT Aware of Cyanide; Was NOT Aware of Rockets]		CSA [Was Aware of Cyanide; Was Aware of Rockets]		Order [Was Aware of Cyanide; Was Aware of Rockets]	
	Phase I (1976-July 1978)		**Phase II (Aug 1978-1982)**		**Phase I (Sept 1983 – 16 July 1984)**	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?
SOCIETY						
Infrastructure	Developed (++)[133]	U	Developed (++)	S	Developed (++)	S
Social/Political Openness	Yes (++)[134]	U	Yes (++)	S	Yes (++)	S
Security Pressure	No (.)[135]	-	No (.)	-	No (.)	-
SOCIAL NETWORKS						
Networked (Genl)	Low (.)[136]	-	Low (.)	-	Medium (.)	-
Networked (VNSAs)	Low (.)	-	High (++)[137]	S	High (++)	S
Demonstration (1st)	C: No (.); R: No (.)[138]	-	C: No (.); R: No (.)	-	C: No (.)[139]; R: No (.)	-
Proselytization	C: No (.); R: No (.)	-	C: Yes (+++); R: Yes (+++)[140]	C: S; R: S	C: Yes (+++); R: Yes[141] (+++)	C: S; R: S
State Sponsorship	No (.)	-	No (.)	-	No[142] (.)	-
Serendipitous Acq.	C: No (.); R: No (.)	-	C: Yes (+++); R: No (.)	C: S; R: -	No (.)	-
PRIOR ADOPTION						
Demonstration (2nd)	C: No (.); R: Yes (+)[143]	C: -; R: U	C: No (.); R: Yes (+)	C: -; R: U	C: No (.); R: Yes[144] (+)	C:-; R: S
# of Successful Prior Adopters	C: None (.); R: Few (+)[145]	C: -; R: U	C: None (.); R: Few (+)	C: -; R: S	C: None (.); R: Few (+)	C: - ; R: S
ORGANIZATIONAL CHARACTERISTICS						
Prior Autarkic Adoption	No (.)	-	Yes (+)[146]	S	Yes[147] (+)	S
Size	Small (.)[148]	-	Med to Large (+)	S	Small (.)	-
Talent Pool Size	N/A (.)[149]	-	Small (.)	-	Small (.)	-
Centralization	High (.)[150]	-	High (.)	-	High (.)	-
Learning Organization	No (.)[151]	-	No (.)	-	Yes[152] (++)	S
Skunkworks	No (.)	-	Yes (+++)[153]	S	No (.)	-
Techne Org.	C: Low (-); R: Low (-)	S	C: Low (-); R: Medium (.)[154]	C: U; R: -	C: Low (-); R: Medium[155] (.)	C: U; R: -
Mētis Org.	C: Low (.); R: Low (.)	-	C: Low (.); R: Medium (.)[156]	-	C: Low (.); R: Medium[157] (.)	-
Safe Haven	Yes (+)[158]	U	Yes (+)	S	No (.)	-

Resource Surfeit	No (.)[159]	-	No (.)	-	No (.)	-
Access to Training Programs	No (.)	-	Yes (++)[160]	S	No[161] (-)	U
Cognitive Biases	Indeterminate (.)[162]	-	Indeterminate (.)	-	Yes (-)[163]	U
Follow-the-leader Bias	No (.)	-	Yes (++)[164]	S	Somewhat[165] (.)	-
Attitude towards innovation	Unknown (.)[166]	-	In favour (+)[167]	S	In favour (+)	S
Affinity for Weapon / Tech.	C: No (.); R: No (.)	-	C: No (.); R: Possible (.)[168]	-	C: No (.); R: Yes[169] (+)	C: - ; R: S
Ideological Compatibility	C: Low (.); R: Low (.)	-	C: High (+); R: High (+)[170]	S	C: High (+); R: High[171] (+)	S
Perceived Urgency	No (.)[172]	-	Yes (-)	U	No (.)	-
Guardians of SQ	Low (.)[173]	-	Low (.)	-	No[174] (+)	S
Active Searching	No (.)	-	Yes (++)[175]	S	?[176] (.)	-
Strategic Compatibility	C: No (.); R: No (.)[177]	-	C:? (.); R:? (.)	-	No[178] (.)	-
WEAPON CHARACTERISTICS						
Information (Entire Tech.)	C: Low (.); R: Medium (.)[179]	-	C: Low (.); R: Medium (.)	-	C: Low (.); R: Medium (.)	-
Techne Weapon	C: Medium (.); R: High (-)[180]	C: -; R: S	C: Medium (.); R: High (-)	C: -; R: U	C: Medium (.); R: High (-)	C: - ; R: U
Commercialized Tech.	C: Yes [Partial] (+); R: Yes [Limited] (+)[181]	U	C: Yes [Partial] (+); R: Yes [Limited] (+)	S	C: Yes [Partial] (+); R: Yes [Limited] (+)	S
Observability	C: Medium (.); R: High (++)[182]	C: - ; R: U	C: Medium (.); R: High (++)	C: - ; R: S	C: Medium (.); R: High (++)	C: - ; R: S
Environmental Persistence	C: Low (.)[183]; R: Low (.)	-	C: Low (.); R: Low (.)	-	C: Low (.); R: Low (.)	-
Active Opp. of Possessors	C: Partial (.); R: Partial (.)[184]	-	C: Partial (.); R: Partial (.)	-	C: Partial (.); R: Partial (.)	-
TOTAL AWARENESS SCORE	**Cyanide: +6-1=5 Rockets: +10-2=8**		**Cyanide: +27-2=25 Rockets: +28-2=26**		**Cyanide: +16-3=13 Rockets: +21-3=18**	

Table B.5.: CSA-Order Adoption Decision Sub-Model

	CSA [Did NOT Decide to Adopt Cyanide or Rockets]		CSA [Did Decide to Adopt Cyanide; Did NOT Decide to Adopt Rockets]		CSA [Did Decide to Adopt Cyanide and Rockets]		Order [Did NOT Decide to Adopt Cyanide or Rockets]		Order [PARTIALLY Decided to Adopt Cyanide; Did NOT Decide to Adopt Rockets]	
	Phase I (1976-July 1978)		Phase II (Aug 1978-1982)		Phase III (1983-April 1985)		Phase I (Sept 1983 – 16 July 1984)		Phase II (16 July 1984 – 8 Dec 1984	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?[185]
SOCIETY										
Infrastructure	Developed (+)	N/A	Developed (+)	C: S; R: U	Developed (+)	C: S; R: S	Developed (+)	U	Developed (+)	C: S; R: U
Security Pressure	No (.)	N/A	No (.)	-	No (.)	-	No (.)	-	Yes (-)	C: U; R: S
SOCIAL NETWORKS										
Demonstration (1st)	C: No (.); R: No (.)	N/A	C: No (.); R: No (.)	-	C: No (.); R: No (.)	-	C: No (.); R: No (.)	-	C: No (.); R: No (.)	-
Cultural Affinity (Homophily)	N/A (.)	N/A	C: Yes (++)[186]; R: N/A (.)	C: S; R: -	C: Yes (++); R: N/A (.)	C: S; R: -	C: Yes (++); R: Yes (++)	U	C: Yes (++); R: Yes (++)	C: S; R: U
Proselytization	C: No (.); R: No (.)	N/A	C: Yes (+++); R: Yes (+)	C: S; R: U	C: Yes (+++); R: Yes (+)	C: S; R: S	C: Yes (++); R: Yes (++)	U	C: Yes (++); R: Yes (++)	C: S; R: U
Serendipitous Acq.	C: No (.); R: No (.)	N/A	C: Yes (+++); R: No (.)	C: S; R: -	C: Yes (+++); R: No (.)	C: S; R: -	No (.)	-	No (.)	-
Intergroup Competition	N/A (.)	N/A	Partial (+)[187]	C: S; R: U	Yes (++)	C: S; R: S	No[188] (.)	-	No (.)	-
PRIOR ADOPTION										
Demonstration (2nd)	C: No (.); R: Yes (+)	N/A	C: No (.); R: Yes (+)	C: -; R: S	C: No (.); R: Yes (+)	C :-; R: S	C: No (.); R: Yes (+)	C: -; R: U	C: No (.); R: Yes (+)	C: -; R: U
# of Successful Prior Adopters	C: None (.); R: Few (+)	N/A	C: None (.); R: Few (+)	C: -; R: U	C: None (.); R: Few (+)	C: -; R: S	C: None (.); R: Few (+)	C: -; R: U	C: None (.); R: Few (+)	C: -; R: U
ORGANIZATION CHARACTERISTICS										
Prior Autarkic Adoption	No (.)	N/A	Yes (+)	C: S; R: U	Yes (+)	C: S; R: S	Yes (C: +; R: ++)	U	Yes (C: +; R: ++)	C: S; R: U

Prior Technology Adoption Outcomes	None (.)	N/A	Successful (+)[189]	C: S; R: U	Partially Successful (.)[190]	-	Mixed / Moderately Successful[191] (.)	-	Mixed / Moderately Successful (.)	-
Size	Small (-)	N/A	Med to Large (+)	C: S; R: U	Small to Med (.)	-	Small (-)	S	Medium (.)	-
Talent Pool Size	N/A (.)	N/A	Small (.)	-	Small (.)	-	Small (-)	S	Small (-)	C: U; R: S
Centralization	High (.)	N/A	High (.)	-	High (.)	-	High (.)	-	Low (++)	C: S; R: U
Learning Organization	No (.)	N/A	No (.)	-	No (.)	-	Yes (+)	U	Yes (+)	C: S; R: U
Skunkworks	No (.)	N/A	Yes (++)	C: S; R: U	Partial (+)	C: S; R: S	No (.)	-	No (.)	-
Cohesiveness	High (+)	N/A	Low (-)[192]	C: U; R: U	Med (.)[193]	-	Low[194] (-)	S	Medium (.)	-
Techne Org.	C: Low (-); R: Low (-)	N/A	C: Low (-); R: Medium (.)	C: U; R: -	C: Low (-); R: High (++)	C: U; R: S	C: Low (-); R: Medium (.)	C: S; R: -	C: Low (-); R: Medium (.)	C: U; R: -
Mētis Org.	C: Low (--); R: Low (--)	N/A	C: Low (--); R: Medium (.)	C: U; R: -	C: Low (--); R: Medium (.)	C: U; R: -	C: Low (--); R: Medium (.)	C: S; R: -	C: Low (--); R: Medium (.)	C: U; R: -
KT Ratio (org)	C: Med (.); R: Med (.)	N/A	C: Med (.); R: Med (.)	-	C: Medium (.); R: Med-High (.)	-	C: Medium (.); R: Medium (.)	-	C: Medium (.); R: Medium (.)	-
Safe Haven	Yes (+)	N/A	Yes (+)	C: S; R: U	Yes (+)	C:S; R: S	No (.)	-	No (.)	-
Resource Surfeit	No (.)	N/A	No (.)	-	No (.)	-	No (.)	-	Yes (+)	C: S; R: U
Access to Training Programmes	No (.)	N/A	Yes (.)	-	? (.)	-	No (-)	S	Partial (.)	-
Cognitive Biases	Indeterminat e (.)	N/A	Yes (+)[195]	C: S; R: U	Yes (+)	C: S; R: S	Yes (.)[196]	-	Yes (+)[197]	C: S; R: U
Follow-the-leader Bias	No (.)	N/A	Yes (.)	-	No (.)	-	Somewhat (+[198])	U	Somewhat (+)	C: S; R: U
Attitude towards innovation	Unknown (.)	N/A	In favour (++)	C: S; R: U	In favour [strongly] (+++)	C: S; R: S	In favour (++)	U	In favour (++)	C: S; R: U
Affinity for Weapon / Technology	C: No (.); R: No (.)	N/A	C: No (.); R: Possible (.)	-	C: No (.); R: Possible (.)	-	C: No (.); R: Yes (+++)	C: - ; R: U	C: No (.); R: Yes (+++)	C: -; R: U

Perceived Urgency	No (.)	N/A	Yes (--)	C: U; R: U	Yes (--)	C: U; R: U	No (.)	-	Yes (--)	C: U; R: S
Champion in Leadership	No (.)	N/A	Yes[199] (+++)	C: S; R: U	Yes (+++)	C: S; R: S	No (.)	-	Yes[200] (+++)	C: S; R: U
Ideological Compatibility	C: Low (--); R: Low (--)	N/A	C: High (.); R: High (.)	-	C: High (.); R: High (.)	-	C: High (.); R: High (.)	-	C: High (.); R: High (.)	-
Veto Players	Yes (-)	N/A	No[201] (.)	-	No (.)	-	No[202] (.)	-	Yes (-)	C: U; R: S
Guardians of SQ	Low (+)	N/A	Low (+)	C: S; R: U	Low (+)	C: S; R: S	No (+)	U	No (+)	C: S; R; U
# of Weapons Needed / Desired	N/A	N/A	C: Single (.); R: Multiple (-)[203]	C: -; R: S	C: Single (.); R: Multiple (-)	C: -; R: U	C: Unknown (.); R: Unknown (.)	-	C: Unknown (.); R: Unknown (.)	-
Risk tolerance	Low (C: --; R: --)	N/A	Moderate-High (C: +; R:+)[204]	C: S; R: U	Moderate-High (C:+; R+)	C: S; R: S	Medium[205] (.)	-	High (C:+; R:+)	C: S; R: U
Active Searching	No (.)	N/A	Yes (++)	C: S; R: U	Yes (++)	C: S; R: S	? (.)	-	? (.)	-
Need to Overcome Countermeasures	N/A	N/A	No[206] (.)	-	Yes (+)	C: S; R: S	No[207] (.)	-	No (.)	-
Need to Overcome Desensitized Public	N/A	N/A	No[208] (.)	-	No (.)	-	No[209] (.)	-	Partial (+)	C: S; R: U
Perceived Advantages of Technology (vis-à-vis SQ)	N/A (.)	N/A	C: High (++); R: Unknown (.)[210]	C: S; R: -	C: High (++); R: Unknown (.)	C: S; R: -	C: No (.); R: No (.)[211]	-	C: Yes (++); R: Unknown (.)	C: S; R: -
Strategic Compatibility	C: No (.); R: No (.)	N/A	C: ? (.); R: ? (.)	-	C: Yes (+); R: Yes (+)	C: S; R: S	C: No (.); R: No (.)	-	C: Yes (+); R: Unknown (.)	C: S; R: -
Perception of ease of Acquisition / Feasibility	N/A	N/A	C: N/A (.); R: Unknown (.)[212]	-	C: N/A (.); R: Unknown (.)	-	C: Unknown (.); R: Unknown (.)[213]	-	C: Unknown (.); R: Unknown (.)	-
WEAPON CHARACTERISTICS										
Information (Entire Tech.)	C: Low (+[214]); R: Medium (.)	N/A	C: Low (+); R: Medium (.)	C: S; R: -	C: Low (+); R: Medium (.)	C: S; R: -	C: Low (.)[215]; R: Medium (.)	C: S; R: -	C: Low (.); R: Medium (.)	-
Techne Weapon	C: Medium (.); R: High (-)	N/A	C: Medium (.); R: High (.)	C: -; R: -	C: Medium (.); R: High (+)[216]	C:-; R: S	C: Medium (.); R: High (-[217])	C: -; R: S	C: Medium (.); R: High (-)	C: -; R: S
Mētis Weapon	C: Low (+); R:	N/A	C: Low (+); R:	C: S; R: -	C: Low (+); R:	C: S; R: S	C: Low (+); R:	C: U; R:	C: Low (+); R:	C: S; R: S

	High (.)[218]		High (.)		High (+)		High (-)	S	High (-)	
KT Ratio (weapon)	C: Med-High (+); R: Medium (.)	N/A	C: Med-High (+); R: Medium (.)	C: S; R: -	C: Med-High (+); R: Medium (.)	C: S; R: -	C: Med-High (+); R: Medium (.)	C: U; R: -	C: Med-High (+); R: Medium (.)	C: S; R: -
Commercialized Tech.	C: Yes [Partial] (+); R: Yes [Limited] (+)	N/A	C: Yes [Partial] (+); Yes [Limited] (+)	C: S; R: S	C: Yes [Partial] (+); Yes [Limited] (+)	C: S; R: S	C: Yes [Partial] (+); Yes [Limited] (+)	U	C: Yes [Partial] (+); Yes [Limited] (+)	C: S; R: U
Financial Cost	C: Low (+); R: Medium (.)[219]	N/A	C: Low (+); R: Medium (.)	C: S; R: -	C: Low (+); R: Medium (.)	C: S; R: -	C: Low (+); R: Medium (.)	C: U; R: -	C: Low (+); R: Medium (.)	C: S; R: -
Economies of Scale	C: No (.); R: Yes (+) [220]	N/A	C: No (.); R: Yes (+)	C: -; R: U	C: No (.); R: Yes (+)	C: -; R: S	C: No (.); R: Yes (+)	C: -; R: U	C: No (.); R: Yes (+)	C: -; R: U
Trialability	C: Moderate (.); R: Moderate (.)[221]	N/A	C: Moderate (.); R: Moderate (.)	-	C: Moderate (.); R: Moderate (.)	-	C: Moderate (.); R: Moderate (.)	-	C: Moderate (.); R: Moderate (.)	-
Observability	C: Medium (.); R: High (+)	N/A	C: Medium (.); R: High (+)	C: -; R: U	C: Medium (.); R: High (+)	C: -; R: S	C: Medium (.); R: High (+)	C: -; R: U	C: Medium (.); R: High (+)	C: -; R: U
Life Span	C: High (+); R: High (+)	N/A	C: High (+); R: High (+)	C: S; R: U	C: High (+); R: High (+)	C: S; R: S	C: High (+); R: High (+)	U	C: High (+); R: High (+)	C: S; R: U
Stability	C: High (+); R: Medium (.)	N/A	C: High (+); R: Medium (.)	C: S; R:-	C: High (+); R: Medium (.)	C: S; R: U	C: High (+); R: Medium (.)	C: U; R: -	C: High (+); R: Medium (.)	C: S; R: -
Environmental Persistence	C: Low (.); R: Low (.)	N/A	C: Low (.); R: Low (.)	-	C: Low (.); R: Low (.)	-	C: Low (.); R: Low (.)	-	C: Low (.); R: Low (.)	-
Active Opp. of Possessors	C: Partial (-); R: Partial (-)	N/A	C: Partial (-); R: Partial (-)	C: U; R: S	C: Partial (-); R: Partial (-)	C: U; R: U	C: Partial (-); R: Partial (-)	S	C: Partial (-); R: Partial (-)	C: U; R: S
TOTAL DECISION SCORE	**(C:+11-10= 1) (R:+10-11=-1)**		**C: +35-7 = 28 R: +24-5 = 19**		**C: +36-6=30 R: +30-4=26**		**C: +17-8=9 R: +21-7=14**		**C: +29-9=20 R: +30-8=22**	

Table B.6.: CSA-Order Adoption Success Sub-Model

	CSA [No Attempt to Adopt Cyanide or Rockets]		CSA [NOT Successful in Adopting Cyanide; No Attempt to Adopt Rockets]		CSA [NOT Successful in Adopting Cyanide; NOT Successful in Adopting Rockets]		Order [No Attempt to Adopt Cyanide or Rockets]		Order [Did NOT Succeed in Adopting Cyanide; No Attempt to Adopt Rockets]	
	Phase I (1976-July 1978)		Phase II (Aug 1978-1982)		Phase III (1983-April 1985)		Phase I (Sept 1983 – 16 July 1984)		Phase II (16 July 1984 – 8 Dec 1984	
Variable	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?	Value (Score)	Support Hyp?
SOCIETY										
Infrastructure	Developed (+)	N/A	Developed (+)	C: U	Developed (+)	C. U; R: U	Developed (+)	N/A	Developed (+)	U
Social/Political Openness	Yes (+)	N/A	Yes (+)	C: U	Yes (+)	C. U; R: U	Yes (+)	N/A	Yes (+)	U
Security Pressure	No (.)	N/A	No (.)	-	No (.)	-	No (.)	N/A	Yes (--)	S
SOCIAL NETWORKS										
Networked (Genl)	Low (.)	N/A	Low (.)	-	Low (.)	-	Medium (.)	N/A	Medium (.)	-
Networked (VNSA)	Low (.)	N/A	High (++)	C: U	High (++)	C: U; R: U	High (++)	N/A	High (++)	U
Demonstration (1st)	C: No (.); R: No (.)	N/A	C: No (.); R: No (.)	-	C: No (.); R: No (.)	-	C: No (.); R: No (.)	N/A	C: No (.); R: No (.)	-
Cultural Affinity (Homophily)	N/A (.)	N/A	C: Yes (+); R: N/A (.)	C: U	C: Yes (+); R: N/A (.)	C: U; R: -	C: Yes (.); R: Yes (.)	N/A	C: Yes (.); R: Yes (.)	-
Proselytization	C: No (.); R: No (.)	N/A	C: Yes (.); R: Yes (.)	-	C: Yes (.); R: Yes (.)	-	C: Yes (.); R: Yes (.)[222]	N/A	C: Yes (.); R: Yes (.)	-
State Sponsorship	No (.)	N/A	No (.)	-	No (.)	-	No (.)	N/A	No (.)	-
Serendipitous Acq.	C: No (.); R: No (.)	N/A	C: Yes (++); R: No (.)	C: U	C: Yes (++); R: No (.)	C: U; R: -	No (.)	N/A	No (.)	-
PRIOR ADOPTION										
# of Successful Prior Adopters	C: None (-); R: Few (.)	N/A	C: None (-); R: Few (.)	C: S	C: None (-); R: Few (.)	C: S; R: -	C: None (-); R: Few (+)	N/A	C: None (-); R: Few (+)	C: S
ORGANIZATIONAL CHARACTERISTICS										
Age of Group	0-2.5 (.)	N/A	2.5-7 (.)	-	7-9.5 (+)	C: U; R: U	0-9 months (.)	N/A	9-15 months	-

									(.)	
Prior Autarkic Adoption	No (.)	N/A	Yes (+)	C: U	Yes (+)	C: U; R: U	Yes (+)	N/A	Yes (+)	U
Prior Technology Adoption Outcomes	None (.)	N/A	Successful (C: .; R: +)	C: -	Partially Successful (C:.; R:.)	-	Mixed / Moderately Successful (.)	N/A	Mixed / Moderately Successful (.)	-
Size	Small (.)	N/A	Med to Large (+)	C: U	Small to Medium (.)	-	Small (.)	N/A	Medium (.)	-
Talent Pool Size	N/A (.)	N/A	Small (-)	C: S	Small (-)	C: S; R: S	Small (-)	N/A	Small (-)	S
Centralization	High (+)	N/A	High (+)	C: U	High (+)	C: U; R: U	High (+)	N/A	Low (.)	-
Spatial Proximity of Organization Elements	High (+)	N/A	High (+)	C: U	High (+)	C: U; R: U	Partial[223] (+)	N/A	No (.)	-
Learning Organization	No (.)	N/A	No (.)	-	No (.)	-	Yes (++)	N/A	Yes (++)	U
Skunkworks	No (.)	N/A	Yes (++)	C: U	Partial (+)	C: U; R: U	No (.)	N/A	No (.)	-
Cohesiveness	High (+)	N/A	Low (-)	C: S	Medium (.)	-	Low (-)	N/A	Medium (.)	-
Techne Org. (similar tech)	C: Low (-); R: Low (-)	N/A	C: Low (-); R: Medium (.)	C: S	C: Low (-); R: High (++)	C: S; R: U	C: Low (-); R: Medium (.)	N/A	C: Low (-); R: Medium (.)	C: S
Mētis Org.	C: Low (-); R: Low (-)	N/A	C: Low (-); R: Medium (.)	C: S	C: Low (-); R: Medium (.)	C: S; R: -	C: Low (-); R: Medium (.)	N/A	C: Low (-); R: Medium (.)	C: S
KT Ratio (org.)	C: Med (.); R: Med (.)	N/A	C: Med (.); R: Med (.)	-	C: Medium (.); R: Med-High (.)	-	C: Medium (.); R: Medium (.)	N/A	C: Medium (.); R: Medium (.)	-
Safe Haven	Yes (+)	N/A	Yes (+)	C: U	Yes (+)	C: U; R: U	No (.)	N/A	No (.)	-
Resource Surfeit	No (.)	N/A	No (.)	-	No (.)	-	No (.)	N/A	Yes (+)	U
Access to Training	No (.)	N/A	Yes (+)	C: U	? (.)	-	No (-)	N/A	Partial (.)	-
Cognitive Biases	Indeterminate (.)	N/A	Yes (C: --; R: ---)	C: S	Yes (C: --; R: ---)	C: S; R: S	Yes (-)[224]	N/A	Yes (--)	S
Follow-the-leader Bias	No (.)	N/A	Yes (+)	C: U	No (.)	-	Somewhat (.)[225]	N/A	Somewhat (.)	-
Ideological Compatibility	C: Low (-); R: Low (-)	N/A	C: High (.); R: High (.)	-	C: High (.); R: High (.)	-	C: High (.); R: High (.)	N/A	C: High (.); R: High (.)	-
Perceived Urgency	No (.)	N/A	Yes (-)	C: S	Yes (-)	C: S; R: S	No (.)	N/A	Yes (-)	S
Champion in Leadership	No (.)	N/A	Yes (+)	C: U	Yes (+)	C: U; R: U	No (.)	N/A	Yes (+)	U

Veto Players	Yes (.)	N/A	No (.)	-	No (.)	-	No (.)	N/A	Yes (-)	S
Guardians of SQ	Low (.)	N/A	Low (.)	-	Low (.)	-	No (.)	N/A	No (.)	-
# of Weapons Needed / Desired	N/A (.)	N/A	C: Single (.); R: Multiple (-)	C: -	C: Single (.); R: Multiple (-)	C: - ; R: S	C: Unknown (.); R: Unknown (.)	N/A	C: Unknown (.); R: Unknown (.)	-
Determination	Medium (.)	N/A	Medium (.)	-	Medium (.)	-	Partial[226] (+)	N/A	Partial (+)	U
Strategic Compatibility	C: No (.); R: No (.)	N/A	C: ? (.); R: ? (.)	-	C: Yes (+); R: Yes (+)	C: U; R: U	C: No (.); R: No (.)	N/A	C: Yes (+); R: Unknown (.)	C: U
WEAPON CHARACTERISTICS										
Information (Entire Tech.)	C: Low (--); R: Medium (.)	N/A	C: Low (--); R: Medium (.)	C: S	C: Low (--); R: Medium (.)	C: S; R: -	C: Low (--); R: Medium (.)	N/A	C: Low (--); R: Medium (.)	C: S
Techne Weapon	C: Medium (.); R: High (-)	N/A	C: Medium (.); R: High (-)	C: -	C: Medium (.); R: High (-)	C: -; R: S	C: Medium (.); R: High (-)	N/A	C: Medium (.); R: High (-)	C: -
Mētis Weapon	C: Low (+); R: High (-)	N/A	C: Low (+); R: High (-)	C: U	C: Low (+); R: High (-)	C: U; R: S	C: Low (+); R: High (-)	N/A	C: Low (+); R: High (-)	C: U
Ease of Acquisition	N/A (.)	N/A	C: N/A (.); R: Unknown (.)	-	C: N/A (.); R: Unknown (.)	-	C: Unknown (.); R: Unknown (.)	N/A	C: Unknown (.); R: Unknown (.)	-
Commercialized Tech.	C: Yes [Partial] (+); R: Yes [Limited] (+)	N/A	C: Yes [Partial] (+); Yes [Limited] (+)	C: U	C: Yes [Partial] (+); Yes [Limited] (+)	C: U; R: U	C: Yes [Partial] (+); R: Yes [Limited] (+)[227]	N/A	C: Yes [Partial] (+); R: Yes [Limited] (+)	U
Financial Cost	C: Low (+); R: Medium (.)	N/A	C: Low (+); R: Medium (.)	C: U	C: Low (+); R: Medium (.)	C: U; R: -	C: Low (+); R: Medium (.)	N/A	C: Low (+); R: Medium (.)	C: U
Technology Maturity	C: Late (+) ; R: Late (+)[228]	N/A	C: Late (+); R: Late (+)	C: U	C: Late (+); R: Late (+)	C: U; R: U	C: Late (+); R: Late (+)	N/A	C: Late (+); R: Late (+)	U
Trialability	C: Moderate (.); R: Moderate (.)	N/A	C: Moderate (.); R: Moderate (.)	-	C: Moderate (.); R: Moderate (.)	-	C: Moderate (.); R: Moderate (.)	N/A	C: Moderate (.); R: Moderate (.)	-
Observability	C: Medium (.); R: High (+)	N/A	C: Medium; R: High (+)	C: -	C: Medium (.); R: High (+)	C: -; R: U	C: Medium (.); R: High (+)	N/A	C: Medium (.); R: High (+)	C: -
Stability	C: High (+); R:	N/A	C: High (+); R:	C: U	C: High (+); R:	C: U; R: -	C: High (+); R:	N/A	C: High (+); R:	C: U

	Medium (.)		Medium (.)		Medium (.)		Medium (.)		Medium (.)	
Active Opp. of Possessors	C: Partial (-); R: Partial (-)	N/A	C: Partial (-); R: Partial (-)	C: S	C: Partial (-); R: Partial (-)	C: S; R: S	C: Partial (-); R: Partial (-)	N/A	C: Partial (-); R: Partial (-)	S
TOTAL SUCCESS SCORE	**(C: +11-7=4) (R: +9-6=3)**		**C: +22-11=11 (R: +18-10=8)**		**C: +20-10=10 R: +17-9=8**		**(C: +15-10=5) (R: +14-7=7)**		**C: +16-13=3 (R: +14-10=4)**	

[1] Although Northern Ireland and the Republic of Ireland were experiencing similar economic problems to the rest of the developed world in the early 1970s, both countries had fairly modern infrastructures, at least in terms of access to information through print, radio or television.
[2] Although access to political power was practically cut off to Catholics in Northern Ireland at the time and there were curfews and similar arrangements in the North that curtailed activity somewhat for Republicans, there was generally freedom of movement between Northern Ireland and the Republic, and once in the Republic of Ireland, PIRA members would have enjoyed extensive freedom of operation and association.
[3] Similar to above.
[4] In this case, the security pressure arguably prompted the PIRA to look for new alternatives in order to circumvent countermeasures.
[5] There were intense security pressures, but there is no indication that this made the INLA more or less likely to be aware of new technology options.
[6] PIRA members were firmly embedded in their communities and there was a lot of support, especially in the Catholic communities in the north and several Republican-leaning areas in the Republic of Ireland. One example of this is the many local farms that were lent to the PIRA to build and test weapons (Coogan, p.34).
[7] The INLA did not have nearly as many connections in either their own community or with other states as the PIRA did.
[8] Although allegedly connected to the PLO as early as 1969, they did not form close connections with other organizations like ETA or the Breton militants until late 1971 or early 1972 (Dillon, p. 392; Maloney, p.9).
[9] During this period, the INLA developed relationships with multiple (mostly leftist) extremist organizations, including the RAF, PLO, CCC, and Action Directe (see Chapter 6 for details).
[10] Although they might have had people in their own Republican network who had used mortars or encountered demonstrations among new-found friends (allegedly including the PLO as early as 1969 (Craig and Geldard p. 65) as well as elements of the Irish government like Captain James Kelly – see Dillon, p. 15) there is no direct evidence of this.
[11] As noted in Chapter 6, the OIRA had planned to use mortars and the PIRA had already made numerous attempts during this period.
[12] There is no evidence of anyone trying to 'sell' the PIRA on mortars.
[13] There is no evidence of anyone from another organization or state encouraging the INLA to adopt mortars.
[14] There are no indications that the PIRA 'stumbled upon' a mortar system at any point in time.
[15] It is likely that in the military manuals the PIRA were consulting they would have come across the possibility of mortars.
[16] As far as the author is aware, no other terrorist or insurgent group had utilized mortars by this time.
[17] During this period, the PIRA had successfully demonstrated their adoption of the mortar.
[18] While still working on adopting a variety of improvised explosive and incendiary devices, at this stage the PIRA probably did not regard any of these as being completely successful.
[19] The adoption of the mercury tilt switch had been a success.

[20] After the disruptive social events (riots and so forth) of the late 1960s, recruits had flooded into the new PIRA. In 1970, the PIRA was estimated to have around six hundred active volunteers (Toolis, pp.23-24) with several hundred more supporters (English, p.114).
[21] The size of the organization varied throughout the period, from 'several hundred' to around forty (see Chapter 6).
[22] While the PIRA had many recruits join during this period, most of these probably lacked the requisite *techne* and *mētis*. The PIRA did have a cadre of trained technicians in the ED, but it is unclear whether during this early period they had the high levels of both *techne* and *mētis* related to weapons development that they did in later periods.
[23] See Chapter 6.
[24] This is a mixed variable, since the PIRA contained some aspects of high control from the centre as well as more decentralized elements. Up until the late 1970s, the PIRA was structured hierarchically, with most power residing in the centre with the Army Council (Coogan, p. 379), but individual units still had a high degree of autonomy (Jackson, 2005, p.134; O'Doherty Interview). Since there were at least some elements of decentralization, the score will be given as if the group was decentralized.
[25] Although there was no leader with absolute control, during this period, major operations were directed and approved by Seamus Costello, followed by Ronnie Bunting and then Dominic McGlinchey.
[26] Although many of its institutionalized learning practices are not explicitly described until later periods, there is still evidence that even the early PIRA sought to learn from its initial mistakes (such as the example of learning from the McCabe and other 'own goals' – see Oppenheimer, p.255 and Jackson, 2005, p. 98).
[27] See Chapter 6 – the INLA did not display most of the traits of a learning organization.
[28] It is unclear exactly when the ED was set up, but all indications are that it was in place by the early 1970s.
[29] At this point the organization was still consolidating its technical skills, which had not reached a high level of proficiency yet in explosives or other technologies related to mortars.
[30] While this is open to some debate, by the late seventies the INLA had demonstrated high proficiency in improvised explosives, including the Mount Gabriel and Airey Neave attacks.
[31] While developing large amounts of *mētis* extremely rapidly, at this early stage, the organization was still developing its *mētis*, which was fairly low (see Oppenheimer, p.254).
[32] At least some members of the organization had become proficient in shooting and bomb attacks, so at this point their *mētis* was probably quite high in terms of conducting attacks with these weapons.
[33] As noted in Chapter 6, the PIRA enjoyed a safe haven in the Republic of Ireland.
[34] While the INLA was primarily an urban-based organization, during this phase it was able to maintain certain training and other activities in the Republic of Ireland, although not to the extent of the PIRA.
[35] There are reports (Craig and Geldard, p. 65) that IRA volunteers did train with the PLO before the split, which may have exposed them to the use of mortars, but this is speculative.
[36] Reportedly, INLA representatives attended training camps in Lebanon (Magill, p.20) and Palestinian experts came to Ireland to train INLA cadre in explosives, particularly car bombs (Craig and Geldard, p.68).
[37] See Chapter 6.
[38] See Chapter 6 for a description of the INLA's financial woes.
[39] The youthful recruits to the new PIRA were intent on striking back at the RUC, Protestants and British in any way they could, with scant regard for the human consequences of their actions. For instance, Oppenheimer describes the state of mind of people like O'Doherty at the time as, 'Preoccupation with the technicalities of bomb-making and deployment, and the excitement and power that entails' (Oppenheimer, p.269).
[40] As described in Chapter 6, both leaders and rank and file members displayed egotism and a desire for self-glorification. Some of the leaders also apparently were narcotics users (Cusack interview). This may have had a slight negative effect on the ability to be open to new possibilities.

[41] Although the PIRA operated strategically and structurally based on a tradition of armed republicanism that went back to the Fenians (Oppenheimer, pp.40-56), there is no indication that there was any prior or contemporary model for the PIRA that utilized mortars.
[42] There are no indications that the INLA sought to follow in the footsteps of the PIRA or any other group – in fact they wanted to outdo these groups, but not necessarily using the same means.
[43] While during this period some of the old guard who set up the IRA were a little reticent at first to endorse exploring novel methods, the young new recruits who had flocked to the organization, like Shane Paul O'Doherty, were extremely keen on innovating and, because there was a surfeit of young volunteers, the leadership generally acquiesced in leaving some to their own devices to experiment; in other words, the influx of new members resulted in the PIRA 'breeding tinkerers at the back' even in the early 1970s (O'Doherty interview).
[44] See Chapter 6 and McDonald and Holland, p.396.
[45] Although not a strong connection, if anything the tendency of mortars to be somewhat inaccurate and hence indiscriminate in their effects, would tend to make them a little less compatible with the PIRA's avowed belief in not causing civilian casualties, at least in Northern Ireland. However, in practice, while not specifically targeting civilians, the PIRA never seemed to be particularly averse to causing civilian casualties, usually justifying them as collateral damage in their war. In addition, attacks on the British mainland expressly targeted civilians.
[46] There are no indications whether mortars would be particularly compatible or incompatible with the INLA's ideology.
[47] The PIRA certainly felt the need to 'take on' the British / RUC and overcome their countermeasures as soon as possible in the period 1969-1971.
[48] Other than their general desire to attack the enemy and keep the organization together, there was no real sense of urgency to engage in attacks. There were certainly concerns about the future of the organization, both structurally and financially, but these did not really lend a sense of urgency as such, except perhaps within the first few months of the organization's existence.
[49] As noted in Chapter 6, there were many old guard leaders at this time who opposed innovation.
[50] There are no specific indications of any guardians of the status quo within the INLA.
[51] The PIRA was actively looking for weapons (Dillon, p. 388; English, p. 115; Moloney, pp.114-115) during this period and were reading military manuals and new product magazines for new ideas (O' Doherty Interview).
[52] Seamus Costello was obsessed with finding weapons with which to arm his new organization (McDonald and Holland, p. 135), and even after his death much of the focus was on procuring arms, e.g., following the Barna Gap robbery in 1978. Yet almost all of the discussion surrounding the INLA's weapons acquisition concerns fairly traditional automatic firearms and explosives rather than rockets or mortars. It is probable, however, that the group was in active procurement mode and would have paid attention to news of any weapon upon which they could lay their hands.
[53] See Chapter 6 for an in-depth discussion of the way in which mortars met the PIRA's strategic needs.
[54] See Chapter 6 for a description of how the INLA had similar strategic concerns to the Provisionals; however, the INLA ostensibly were less interested in destroying some commercial targets because it was contrary to the interests of the working class (Craig and Geldard, p. 13). However, if used correctly, mortars could still be focused on security force and government targets.
[55] While the basic functions of mortars were fairly well-known, aspects of their use and construction were available mainly in state militaries and this variable does not receive a positive score.
[56] Mortars were a weapon that was more sophisticated than small arms, hand grenades or improvised explosives and required some degree of skill even to operate, let alone produce.
[57] Mortars were available at the time on the international arms market, but – at least for the legitimate part of this market – purchase was limited to states.
[58] Mortars were primarily available for sale to states, but there were no active international controls on their sale or transfer.

[59] This was operative throughout the period, from internment, to Operation Motorman and the use of targeted killings, infiltration and informants in the 1980s. See Bradley and Feeney (pp. 206, 259 and 289) for examples.
[60] Their own previous attempts serve as a demonstration for later decisions.
[61] It is unclear whether the PIRA actually adopted mortar technology from any external actors, but supposing that it did, the most likely suppliers would have been the PLO, with whom Irish Republicans did not have any cultural similarities.
[62] The reported attempts to purchase mortars externally in 1977 again involved the PLO (Dillon, p. 399), with whom the PIRA had little cultural similarities. Thereafter, the next most likely supplier would have been the Libyans, which was again hardly an instance of homophily.
[63] During both phases, there were similar entities – the PIRA and OIRA – who had attempted to, or actually used, mortars. While there were intense strategic and political differences between the INLA and these organizations, culturally and socially there were similarities in background and membership, i.e., Republican, Catholic and predominantly working class.
[64] The PIRA initially competed with the OIRA, then with the INLA and later with the IPLO, which the Provisionals essentially wiped out in 1992.
[65] There was, of course, the 1975 feud between the INLA and the OIRA, but the INLA was also driven to compete with the PIRA (see McDonald and Holland, p.265; Dillon, p. 261).
[66] During the second phase, the internal instability of the INLA relegated any competition to the backburner, in fact, there are reports (McDonald interview) that the two organizations actually collaborated during the early 1990s. Parts of the INLA did compete with the IPLO, but others cooperated with it, so on balance, there does not seem to have been a large intergroup rivalry.
[67] This refers to the organization's early attempts at producing explosives.
[68] Previous models of mortars qualify here.
[69] The mercury tilt switch is the seminal example here.
[70] The feuding, supergrass trials and other factors led to the INLA's active membership being restricted to several dozen active members; estimates are between forty to fifty persons (see Chapter 6, ftn 189).
[71] In operational terms, the local units, at least at the Brigade level, had a lot of autonomy (O'Doherty interview).
[72] With the introduction of Active Service Units in the late 1970s, which were largely responsible for their own funding and targeting, operations became even more decentralized (Maloney, pp.156-157; Toolis, p. 319).
[73] As detailed in Chapter 6, there were multiple loci of power and command during this period, with different factions vying for control and acting independently.
[74] See Jackson, 2005, passim, Maloney, p.174, and Horgan and Taylor, p. 27 for evidence that the PIRA acted as a learning organization over the entire period.
[75] In the mid-to-late 1970s, the PIRA experienced a degree of factionalization as the old guard based in Dublin were displaced by a new crop of reformers in the North led by Gerry Adams and Martin McGuiness. By 1986, however, the new faction had gained control of the organization (for more detail see Dillon, p.54, 75; Bradley and Feeney, p.175).
[76] During this period there was internal friction over the central leadership surrounding Gerry Adams beginning to emphasize the political work of Sinn Fein over military operations, which many stalwarts of the armed struggle (correctly) viewed as a prelude to a peace process and the giving up of arms.
[77] There was a fair amount of internal dissension during this period, but the organization had strong leaders who kept it together.
[78] As detailed in Chapter 6, the INLA was riven by feuds during the second phase.
[79] See Chapter 6.
[80] Owing to a loss of key personnel through feuds and incarceration, and the quality of new recruits declining over the second period, it can be assumed that the general degree of technical knowledge decreased considerably. It is certainly true that there were no new technical innovations during this period. However, since it is not known for certain how large

the diminution in technical capabilities was and we know that the group retained basic bomb-making abilities as late as 2005 (John Mooney, 'Dissident Republicans Linked to Dublin Pipe Bombs', *Sunday Times, London* (June 1, 2008), p.8), to be conservative, the value is only reduced to 'medium'.

[81] See Chapter 6 for a discussion of the capabilities of PIRA personnel. Also see Jackson, 2005, pp. 107, 121 and Coogan, p. 384.

[82] It can be assumed that *mētis* also decreased together with *techne*, by an even greater amount – it is reported that from the late 1980s until 1992, for example, the INLA had failed to kill or seriously injure a single member of the security forces (McDonald and Holland, p. 416) – even after the feud had subsided.

[83] These persisted throughout the Troubles, although by the late 1980s, the Garda had become more proficient at identifying and raiding PIRA safe-houses, storage depots and factories in the Republic.

[84] By the late 1980s, it appeared that the Garda had begun to pursue the INLA more rigorously, and the organization had been eviscerated by feuds and infiltrators, but it is unknown to what extent this affected their safe-houses in the Republic and elsewhere.

[85] Oppenheimer (p.154) states, 'The IRA's finances actually came under pressure during the 1980s due to further infiltration of the organization with highly placed informers, as well as demands on funding by Sinn Fein's increased political activity.'

[86] Despite its multiple sources of income, Maloney (pp. 459-460) argues that by the mid-1990s, '… the organization was broke and owed money everywhere, not least to Slab Murphy, who had lent the IRA some of the proceeds from his cross-Border business operations, and had not been repaid.'

[87] Although most of the cadre either learned themselves or were trained internally by the PIRA, at least some members were trained in Libya (Coogan, p. 436) or with Fatah (Oppenheimer, p. 97) and others, such as Danny McNamee, attended university to hone their skills. This occurred during the 1970s, and it is unclear to what extent it continued thereafter. See Chapter 6 for details. There may also have been a PIRA training camp in Algeria (see Craig and Geldard, p. 67).

[88] There is no evidence of any new training programmes in the second phase and it is unclear whether or not the INLA still had access to its earlier training programmes.

[89] The same biases persisted into the second phase as in the first, except perhaps even exacerbated by the brutality of the internal fighting and hatred as former comrades turned on each other.

[90] See endnote 42.

[91] An example that indicated that the PIRA was still an innovative organization in general is the following from Eamon McGuire, ' "So, I felt, here was an army that had all the latest training, weaponry and technical know-how: was there any way that I could help to face down such an army?" Could I confuse their technicians, second-guess their strategies and their tactics? I returned to the desert of the Middle East to work out how the cutting-edge technology of that time could be integrated into modern guerrilla warfare to offset all these enemy advantages' (McGuire, pp.211-212).

[92] There is no information after the early period of the INLA seeking to adopt new practices or technology.

[93] See endnote 45.

[94] After their initial flurry of activity in establishing themselves, there is no evidence that the PIRA ever perceived a high degree of urgency in its operations.

[95] There is no clear evidence of any single individual within the upper echelons of the PIRA who championed mortar development.

[96] While there were several members generally in favour of innovative attacks, there is no evidence of any member, least of all a member of the leadership, pushing for mortars.

[97] There is no mention of any specific veto players in the organization as a whole – decisions were taken mostly collaboratively within the Army Council – or specifically with respect to mortars.

[98] Costello had a powerful voice, but even he was disobeyed by the Belfast membership on occasion; however, when McGlinchey took over, he ruled with an iron fist and could have been said to have possessed veto authority.

[99] Most of the leaders in the second phase were fairly weak and cannot be said to have had veto authority, especially in the presence of so many factions. Neither could any of the individual faction leaders veto any decisions of the other factions, except through assassinating the other leaders.

[100] See Jackson, 2005, p.136.
[101] After 1973, there is no evidence of any individuals who pushed the organization in a conservative tactical direction.
[102] There is no evidence that there were any such actors active in the group during this phase.
[103] The PIRA clearly sought to use mortars extensively.
[104] While it is unknown how many mortars the INLA might have sought, they generally wanted to carry out as many attacks as possible during this period, so it can be inferred that they would have preferred more than a handful of mortar systems.
[105] See, for example, Oppenheimer, p.249, O'Doherty, p. 41, Bradley and Feeney, p.121 and O'Doherty interview.
[106] The record of risk tolerance from the 1980s on is mixed. On the one hand there are many reports that operations were routinely cancelled if they were viewed as too risky (Bradley and Feeney, p. 280), while at the same time the Engineering Department embarked on the extremely risky and potentially hazardous production of detonators (Oppenheimer, p. 204). Since we are concerned here mainly with the production of weapons, we will take the latter activity as indicative that at least the technicians were still willing to take substantial risks for the cause.
[107] The INLA engaged in many risky behaviours, such as the Mount Gabriel attack and the St. Patrick's Cathedral plot (McDonald and Holland, p.161). See also McDonald and Holland, p. 93.
[108] There is no evidence to suggest that their risk tolerance decreased.
[109] During this phase, the PIRA was still intent on building up its weapons capabilities as much as possible (Dillon, pp.393-394; Brian and Feeney, p.96).
[110] If anything, the PIRA increased their attempts to expand their arsenal during this period, engaging in acquisition activities ranging from buying up all the Memopark timers they could purchase to use in bombs (Craig and Geldard, p.39), to attempts to buy a Red-eye missile in the United States (Moloney, p.16), to becoming involved with the large Libyan arms shipments of the mid-1980s. Also, see McGuire, p. 227. Most of all, there is evidence of a continued interest in mortars, with the PIRA reportedly attempting to smuggle them in the 1977 electric transformer smuggling case (Dillon, p. 399-400).
[111] Despite losing Libyan assistance and much of its American supply lines, the PIRA was still intent on acquiring a range of weapons during this period. The evidence found during the Garda raid on the Clonaslee arms 'factory' in 1996 revealed 'forty mortar tubes, Semtex, large amounts of ammonia and nitrate used in homemade explosives, along with switches, timers, detonators, guns, tail fins and other mortar parts' (Oppenheimer, p.359), which indicated that their interest in mortars was undiminished. Also, see McGuire, p.263.
[112] Although not very successful in the second phase, the INLA still seemed to be looking for weapons wherever they could find them, including sourcing from black market dealers (McDonald and Holland, p.430) and even utilizing the services of William Wallace Norton, a retired Walt Disney screenwriter, in an attempt to smuggle weapons into Ireland (J.L. Stone Jr., 'Irish Terrorism Investigations', *FBI Law Enforcement Bulletin* (October 1987), pp. 22-23). However there are no indications that they were specifically searching for a mortar capability in either phase. Nonetheless, it is assumed that they were still actively searching for weapons that could fulfil their perceived needs, as in the initial phase.
[113] See the accompanying discussion for the countermeasures that spawned the first interest in mortars. This persisted right through the 1980s and into the 1990s. There were, for example, almost no other options for a direct, targeted attack on Number 10 Downing Street than mortars. For the general need to circumvent British countermeasures, see Oppenheimer, pp. 150, 199, 204, 141, 277; Collins and McGovern, p. 156; and McGuire, pp. 256-257.
[114] During the early stages, there were clear attempts to reach targets despite countermeasures (cf. the Neave assassination), but this was not as strong as in the case of the PIRA.
[115] Since there was very little activity against the security forces during this period, but more a struggle for survival from internal and external threats, there is no evidence of a desire to circumvent the target hardening by the authorities.
[116] There are multiple examples of public outcry over the actions of the terrorists in Northern Ireland, although on the mainland, Oppenheimer (p. 29) opines that the British public had become inured to the violence of the PIRA over the years.

[117] There is no evidence that the public had become desensitized to the Troubles during this phase. In fact, both sides (Catholic and Protestant) routinely expressed outrage at the INLA's actions, for example, see McDonald and Holland, p. 260.
[118] See endnote 116.
[119] After some success had been achieved with the advent of the Mark 6, most subsequent models demonstrated a more moderate change from the status quo. This was not necessarily how these would be perceived, though, so the value for this variable after 1974 is given as 'Unknown'.
[120] There are no indications how the INLA might have viewed mortars with respect to the status quo – while the INLA no doubt would have liked to attack hardened targets, they also seemed content to concentrate on their existing shooting and bombing activities.
[121] There is no available information (short of the fact that the PIRA persisted with its mortar efforts), regarding how key decision-makers perceived the ease of acquiring mortars.
[122] There is no evidence as to how the INLA viewed mortars in terms of ease of acquisition or use.
[123] As shown by the initial failures not only to produce a reliable weapon, but to even use it discriminately, it can be assumed that the *mētis* required for using (and even more so for developing) a mortar system is substantial.
[124] In terms of internal development, trialability is relatively low – one has to commit to quite a lot of investment before being able to fire the first shot. A ready-made, commercial system is readily trialable though.
[125] Almost all reports of INLA connections with other VNSAs end in the mid-1980s, with the last report referring to the INLA's rejection of a Libyan offer of arms. By 1987, the INLA's main contact in the European extremist left, Action Directe, was essentially destroyed, thus cutting off this line of support. However, INLA's links with Fatah and other PLO factions, as well as other sympathizers in Europe, may have continued past this date.
[126] During this period, although there were some connections with Ireland and potentially Algeria and some Eastern European states, this was not as robust as in the mid-1970s or 1980s when Libya was the PIRA's main state benefactor.
[127] According to Holland and McDonald (pp. 303-304), in 1986 Libya approached the INLA with offers of weapons but these were rebuffed because the INLA lacked the capacity to absorb them. Besides certain Eastern European states allegedly turning a blind eye to the INLA's activities, there was no real state sponsorship and the OIRA's extensive links with groups such as the Stasi did not carry over to the INLA (McDonald interview).
[128] The mercury tilt switch and standard explosives rely on quite different technology than the propulsion systems required for mortars, so their success in these areas would not necessarily translate directly into prospects for success in the development of mortars.
[129] Throughout their existence, there were tensions between the Dublin and Belfast factions of the INLA, with many members spread out all over the island. According to Henry McDonald, they 'were always stretched geographically' (McDonald interview).
[130] It is unclear how the internal fighting of its members would bias their implementation of any adoption decisions, but their rash egotism (present throughout) is surely not conducive to successful development of a new weapons capability.
[131] During the early years under Costello and then McGlinchey, the INLA seemed to be completely committed to their militarism and causing as much mayhem as possible. After the feuds broke out in the second phase, it can be argued that the group was too distracted by internal rivalries to remain nearly as focused on their strategic or tactical objectives.
[132] Although the model prescribes a '++' for commercially available technology, legitimate sale of mortars was generally limited to specific state actors. While the PIRA could have obtained these weapons on the black market, this was more difficult and fraught with the danger of interdiction (which is what mostly did occur with attempts to import mortars). This limited availability is thus reflected with a '+'.
[133] The United States was amongst the most developed nations on earth throughout the period of analysis. Even though the area in which the CSA compound was situated – the Ozarks – and many of the rural, sparsely populated areas where the Order operated out of were some of the least developed parts of the United States, the general infrastructure made almost any resources and technology available to the CSA and the Order.

[134] The open democracy of the United States, especially the protections afforded to religious practice, weapons ownership and entrepreneurship, meant that there were no broader social constraints acting to inhibit awareness or adoption of innovations. In fact, the CSA enjoyed flaunting their weapons when they left their compound (Noble, p.81).

[135] While law enforcement (both at the local and federal levels) had been aware of the CSA and had some concerns as early as 1978 (Hamm, p. 107, Noble, p. 122) and had even discussed raiding the compound as early as 1983 (*Memorandum: SAC, Little Rock to Director, FBI*), it was not until 29 January 1985 that a full domestic terrorism investigation was launched (*Declassified FBI Memorandum, Little Rock Office*, dated 2 July 1987), and not until April 1985 that the compound was searched. There were no significant security pressures during the development of either the cyanide or the rocket plots.

[136] Throughout the entire period from 1976-1985, the CSA was isolated from the mainstream culture, as Kerry Noble states: 'We were not content to be merely separated from society; we put ourselves in a position to be totally isolated and insulated from it. We rarely kept up with the news of the world. The only input we were eventually receiving was from publications by various neo-Nazi and KKK groups, other Christian survivalists groups, or individuals like John Todd – constantly feeding us fear, hate, and paranoia' (Noble, p. 113).

[137] From mid-1978 onwards, the CSA was increasingly embroiled in the far-right survivalist and Identity milieu (see Chapter 7).

[138] There is no indication that anyone within the right-wing milieu had used either cyanide or rockets during this period.

[139] See above endnote. Even though some Order members who had previously been at the CSA compound may have heard about the cyanide that CSA had on hand, this did not constitute a use of the weapon, which this variable applies to.

[140] Robert Miles had given the CSA the cyanide in 1981 and the Turner Diaries, with its tacit advocacy of rockets and mortars (see Chapter 7), had been published in 1978.

[141] Poisoning of water supplies had been advocated at the clandestine 1983 gathering of right-wing leaders. Rockets had been advocated in the Turner Diaries (see Chapter 7).

[142] Although they did not receive any state sponsorship, the Order made overtures to the Syrian government for support in their struggle against the Jews (Flynn and Gerhardt, pp. 98-100, 323; Hamm; p. 140-141, 147; Singular, pp. 246-247).

[143] The PIRA in particular had already made media headlines with their use of home-made mortars and rockets by this time (see PIRA case study). There were no prominent cases of cyanide use by militant groups to cause mass casualties during any of the three phases (the infamous Tylenol tampering case only occurred in September and October of 1982 and, moreover, was not a mass-casualty attack). The closest to a previous use of cyanide by the far right milieu occurred in 1970 when a stream which acted as the water supply for cattle on a farm in Alabama that was owned by African-American Muslims was poisoned, resulting in approximately 30 cows dying. Certain reports identified the poison as cyanide and the Ku Klux Klan may have been implicated, although both of these pieces of information are unclear. See, 'Poison Is Suspected in Death of 30 Cows on a Muslim Farm', *New York Times* (16 March 1970), p. 30. This case was unlikely to have served as a 'demonstration' of cyanide's mass-casualty potential and is therefore not coded as such.

[144] See above.

[145] Throughout all phases, no state or non-state actor had used cyanide as a mass-casualty weapon. The PIRA and some of the Palestinian insurgent groups were among the few who had used rockets against their enemies by this time.

[146] From Phase II onwards, the CSA had successfully developed the capability to convert firearms on their own, as well as to produce firearm accessories like flash suppressors and silencers.

[147] The group had built some reasonably effective explosives in early 1984 (see Table 7.2).

[148] CSA had an estimated 50 members in 1978, 130 in 1982 prior to the split and only around 50-75 after the split (Noble, pp. 20; 86-87; CSA FBI Files 1982 Report; Grand Jury Testimony of James Ellison).

[149] In Phase I, there was no real weapons development, while even in Phases II and III, there were only ever a handful of members with the requisite *techne* and *mētis*.

[150] For its entire lifespan, the CSA was highly centred on James Ellison and the CSA compound (originally known as Zarephath-Horeb).

[151] Although they trained hard and increased their military capabilities, there are no indications that the CSA consciously incorporated learning mechanisms within the organization, or even that they assessed failures methodically.

[152] The Order did analyse its operations and attempt to learn from its mistakes (although it was not always successful in implementing its learning). Examples include when Daniel Bauer and Denver Parmenter visited a university library to learn more about explosives in November 1983 (Flynn and Gerhardt, p. 106), when Richard Scutari was brought on board in order to improve security (Hamm, pp. 132-133), and when Bruce Pierce insisted that his cell of robbers attach lanyards to their weapons to avoid a repetition of Robert Mathew's loss of his weapon during the Ukiah robbery (Flynn and Gerhardt, p. 282).

[153] From the second phase and the setting up of the machine shop to convert weapons, CSA had an entity whose specific function was to work on weapons, with Randall Rader actively exploring military matters. After Rader left the CSA, Kent Yates took over this role, but appeared to be less independent-minded than Rader and took orders from Ellison, thus making this function less independent of the central leadership.

[154] The CSA did not possess any chemical expertise throughout its lifespan, but it gained some machining and weapons expertise (related to rockets) after 1979.

[155] There is no evidence that anyone in the Order had any knowledge of how to work with or deploy cyanide. With respect to rockets, there was at least one member with machining knowledge (Rader) and several members with explosives knowledge.

[156] The CSA never worked with or recruited anyone who worked with cyanide. As for rockets, they had some experience converting firearms to automatic versions and producing silencers, as well as basic military tradecraft. After 1982, they also had several experiences of fielding weapons, but these were never very successful, which implies that their *mētis* with respect to explosives was medium at best.

[157] Similar to above with respect to cyanide. In addition to technical knowledge, Rader had experience in actually machining weapons, while Yarbrough and Pierce had actually manufactured explosives, at least a few times.

[158] Although not completely secure – the U.S. government had allegedly been able to infiltrate several informers over the years into the compound – the remoteness of the CSA property, as well as the freedoms afforded religious communities in the United States, meant that it could continue its weapons acquisition and development activities for several years without detection or disruption.

[159] The CSA, while able to pool sufficient money to buy substantial stocks of weapons, were mostly close to poverty for their entire lifespan (see Chapter 7).

[160] From late 1978, CSA members engaged in prolific military training programs (Noble, pp. 81; 91). These seem to have diminished after Rader left (Report of interview with Rudy Loewen (2 May 1985), presented as evidence in *United States of America v. James D. Ellison et. al.* (CR85-20017)), but most likely continued in some reduced fashion in Phase III.

[161] Initially, although some members had had prior military or paramilitary training at the CSA or elsewhere, there were really few avenues to increase their capabilities. Later, once Randall Rader was brought into the organization and had the funds to set up training facilities, this became possible, however, the camps were poorly run and largely unsuccessful in their training goals (Flynn and Gerhardt, pp. 327-328).

[162] James Ellison displayed numerous cognitive biases, including paranoia, narcissism and intense superstition. However, while affecting his ability to see a project through, there is no indication that they acted to affect his awareness of potential new weapons (see Chapter 7 for a full discussion of these issues).

[163] Initially, the predominant biases were the action orientation of senior members (like Mathews and Pierce), as well as Mathews's self-reliance, which arguably could have made him less likely to be aware of opportunities in the broader environment with respect to weapons.

[164] Although Rader modelled his Silhouette City training venue after the FBI's Quantico facility, this was not really following a leader within his own network. Ellison, however, was especially interested in setting himself up as a prominent member of the far right, emulating many of their prominent leaders, for example, in 1982 even copying a routine used by Louis Beam of the KKK – tossing a piece of meat to the 'federal dogs' (Noble, p.129).

[165] It is clear that Mathews and the Order sought to follow closely the precepts laid out in the *Turner Diaries* and were inspired to emulate the exploits of the fictitious group in the novel. However, this group could not provide a real-world model for Mathews and when it came to the real leaders of the movement, Mathews believed that they talked too much and acted too little. Thus, rather than seeking to emulate them, he sought to provide inspiration to them through the actions of his own group (see the Order case study in Chapter 7).
[166] At this stage, the CSA were primarily isolationist.
[167] During this phase, Rader in particular was interested in new weapons and materials, and the far right movement as a whole accepted innovation, at least of the technical kind (Barkun, 1996, pp. 55-57).
[168] Although both cyanide and rockets were weapons that aligned with their strategic outlook, there was no particular affinity for cyanide. From Phase II, however, it can be argued that the influence of the *Turner Diaries* in the far right community and the prominent place that rockets played in it, created an affinity for these weapons. However, there is no direct evidence that Ellison was influenced by the Turner Diaries at a tactical level, as was the case with Bob Mathews and Timothy McVeigh.
[169] There is no evidence of a particular affinity for cyanide, but there was certainly likely to be one for rockets (see Chapter 7).
[170] As soon as the group began embracing a millenarian outlook, with tropes of a conflagration and widespread destruction in which they might have to play a role, both weapon types became ideologically compatible.
[171] See Chapter 7 for details regarding the mass-casualty ideological tendencies of the Order.
[172] CSA operated initially as a refuge from the corruption of the world, but after mid-1978, when Ellison began prophesying the impending apocalypse and later on a race war, there was a perceived sense of urgency attached to everything the CSA did.
[173] Noble (and at times others) opposed some of Ellison's decisions and on occasion resisted change to a more violent footing, but Ellison rarely paid much heed to this and the followers continued to go along with Ellison.
[174] Although there were some Order members (such as Rader, Loff and Bauer) who were more hesitant to engage in certain violent activities, and others such as Pierce who differed with Mathews as to command and control matters, as a whole the group was action-oriented and innovative and wanted to break away from the status quo.
[175] During this phase, the CSA were busily accumulating weapons, travelling to gun shows and reading military manuals (Hamm, p. 91; Noble, p. 81).
[176] Evidence for this is mixed. On the one hand Pierce and several of the other members were avid technofiles, and Roberts did try to acquire a rocket tube. On the other hand, there is no evidence that the group actively sought out any weapons besides small arms or explosives.
[177] There were no plans for mass-casualty attacks in Phase I. In Phase II, although there had been a conversion to Identity thought by 1980, and there was a lot of talk about preparing for war (for instance, Rader apparently made plans in 1982 to attack a dam – Hamm, p.100), it is unclear what Ellison's actual strategy was during this time. By mid-1983, however, the strategy had clearly become large-scale conflict with the government.
[178] See Order case study in Chapter 7 for an extensive discussion.
[179] While cyanide was known to be a toxic chemical, the amount of information widely available on its usage as a mass-casualty weapon was minimal. Similarly, rockets were well-known military weapons, although the details regarding their fabrication were not.
[180] The chemical and engineering principles associated with using cyanide as a mass poison require some technical background, but are not especially complex when compared to the production and distribution of other chemical weapons, such as nerve agents. Rockets require a significant amount of technical knowledge (related to machining, explosives, detonators and propellants) to produce.
[181] Throughout all phases, cyanide was readily commercially available for use in industry and agriculture, but the delivery mechanisms and amounts needed to cause mass casualties remained within the purview of states. Similarly, rockets were available for purchase on international arms markets, but their sale was generally also restricted to state actors.
[182] The effects of cyanide are not immediately apparent, but can usually be determined by forensic investigation; rockets are immediately observable.

[183] 'Environmental and Health Effects of Cyanide', *International Cyanide Management Code For the Manufacture, Transport, and Use of Cyanide In the Production of Gold*. Accessed at http://www.cyanidecode.org/cyanide_environmental.php on 26 October 2013.

[184] Although there have been federal, state and local regulations since the 1970s in the United States regarding cyanide, most of these are designed to prevent environmental damage from industrial or mining applications. It was reported that the purchase of cyanide was limited to research and industrial purchasers, but as late as 2003, cyanide in bulk quantities was available online in the United States (Sara Rimer, 'Cyanide Purchase is Linked to Death in Nashville', *New York Times* (1 March 1986). Accessed at http://www.nytimes.com/1986/03/01/us/cyanide-purchase-is-linked-to-death-in-nashville.html on 26 October 2013; 'Interview with Dr. Sanjay Gupta: Cyanide poison hard to detect', *CNN* (10 January 2003). Accessed at http://articles.cnn.com/2003-01-10/us/otsc.gupta.cyanide_1_potassium-cyanide-benjamin-vassiliev-ryan-furlough?_s=PM:US on 26 October 2013). Rockets, while ostensibly available only to government purchasers, were not strictly controlled internationally in the 1980s. The ability of the CSA to procure a working LAW rocket illustrates this (see Chapter 7).

[185] Owing to the fact that the outcome for cyanide is equivocal, it is not possible to make firm judgments on whether the hypotheses relating to the decision to adopt cyanide are supported. However, for the purposes of discussion, it will be assumed that there was a positive decision to adopt cyanide as a mass-casualty weapon to be used through the water supply.

[186] There were close cultural affinities between Miles' group and the CSA.

[187] During the initial part of Phase II, it appears as if Ellison and the CSA were merely trying to stake their claim as legitimate members of the far right Identity movement. However, during the latter stages (from 1982 onwards), Ellison intended to dominate the movement and thus was implicitly competing (while simultaneously cooperating) with the other organizations. From 1983, Ellison did seem to be trying to fortify his claim to leadership of the movement, but this was still a state of cooptation (a combination of competition and cooperation commonly seen among multinational corporations).

[188] There is no mention in any of the sources of Mathews seeking to compete with the rest of the far right. Although his frustration with their lack of action was one of the impetuses for creating the Order, it appeared as if he merely wanted to catalyse and invigorate the white supremacist movement rather than compete with any group. Further evidence can be found in his desire to support most of the key far right entities financially with the proceeds of his actions.

[189] This includes the weapons fabrication and conversion.

[190] During this period there were successes as well as failures (for example, bombs causing only minimal damage).

[191] Although they had managed to successfully detonate an explosive in the Embassy Theatre bombing, other attempts, such as the synagogue bombing, were less successful. In terms of the electronic surveillance technology they had adopted, they believed that the voice stress analyser and transmitter detection technology worked.

[192] During this period there was increasing opposition to Ellison's rule, primarily by Randall Rader and then by several other elders upon learning of Ellison's polygamous intentions, culminating in the split at the end of 1982 (see Chapter 7).

[193] After the split, the remaining CSA was generally united behind Ellison, although several people, including Noble, were still clearly dissatisfied and continued to question Ellison's decisions and actions.

[194] In addition to the simmering tensions between Bruce Pierce and Mathews, there were several other disagreements, ranging from objections to the assassination of Berg and several members dropping out in the first few months. Even though structurally the Order was more diffuse in Phase II, they were arguably somewhat more cohesive, although there was increasing dissatisfaction amongst some members with Mathew's erratic behaviour in the last few months of 1984.

[195] Ellison's narcissism and belief in his and the CSA's centrality most likely would bias him in favour of attempting to adopt new weapons, irrespective of the difficulties involved.

[196] The biases here seem to act in opposite directions on the variable of interest. On the one hand, Mathew's self-reliance and belief in his ability to change history might have made him more likely to want to adopt innovative weapons, while, on the other hand, his action-orientation would seem to argue against his having the patience to engage in any sort of development or complex acquisition activity.

[197] It can be argued that Mathews' increasing recklessness and desire to move on to step six of his strategic plan meant that he would be more likely to embrace new weapons.
[198] Because this is only partially the case, a weaker effect is predicted than shown in the model.
[199] Both Rader and Ellison seemed to favour developing new technologies (like the firearm conversions) during Phase II and Ellison was in favour during Phase III.
[200] While Mathews was by no means inimical to adopting new technologies or weapons, he did not take this as a central element of his thinking. Rather, it was really Pierce and others who seemed keen on pushing for new technologies, and it was not until these individuals took on more of a leadership role in Phase II that one might argue that there was a technology 'champion' making tactical decisions.
[201] By Phase II, Ellison was the sole decision-maker and, besides him, there were no veto players.
[202] Initially, Mathews alone seemed to have veto authority (for instance when he ignored objections to assassinating Berg or rejected the Rothschild bomb plot), but in Phase II, when authority was more dispersed, at least at a tactical level, there was a lot more autonomy and it can be argued that other members possessed some degree of veto power, at least in terms of weapons selection (see Chapter 7).
[203] There are no indications that the CSA ever sought more than the single barrel of cyanide; as for the rockets, Ellison realized that many would be needed to destroy a large building, so they clearly planned on pursuing the acquisition of multiple rockets. It is unknown whether they intended using the rockets for other attacks besides the Murrah Federal Building attack, although it can be argued that, were they successful with the first attack and had already produced a dozen or so rockets, they would have continued attempting to use them.
[204] Ellison was not at all risk averse: he participated in attacks and other crimes himself – even being caught shoplifting at one time – and was willing to countenance increasingly brazen attacks.
[205] While engaging in fairly risky robberies and assassinations during Phase I, the group almost always engaged in extended preparations and intelligence gathering. However, in Phase II, when authorities were closing in, Mathews especially began to take increasing risks, several of which could be described as negligent (see Chapter 7).
[206] There are no indications that the envisaged use of cyanide was to overcome any specific countermeasures. With respect to rockets, they were specifically sought in 1983 to enable the standoff destruction of a federal building, presumably because an inside attack was believed to be too risky considering the security attached to federal buildings.
[207] There is no indication that the Order was seeking weapons to overcome any specific countermeasures in general.
[208] There is no evidence to suggest that either the cyanide or the rockets were intended to arouse a public that had been desensitized to violence. Rather, the main purpose of the cyanide was to kill sinners and of the rockets was to provoke the government and initiate a war (see Chapter 7).
[209] During the first phase, most of the Order's activities were centred on building the organization, with the possible exception of the murder of Alan Berg (although that seemed to emerge more from a punitive desire to strike back at the Jews and show them to be vulnerable). Near the end of Phase II, however, they began to enter step six of Mathews' plan, which involved announcing their intentions to the world through their declaration of war and so forth. Although the primary aim was to initiate the revolution, implicit within this might have been a desire to wake the white masses from their ignorance of the threat to their race (as envisaged in the *Turner Diaries*).
[210] The CSA perceived that cyanide enabled truly biblical-scale attacks, which was a vast improvement over the small arms they possessed at the time. It is unknown how they viewed rockets relative to the bombs they already had, since rockets did not allow them to do something that they couldn't have done with a large truck bomb, i.e., destroy a federal building (see Chapter 7 for details).
[211] Based on Mathews' strategic outlook, these weapons offered no real advantages during Phase I; however, by the end of Phase II, cyanide would allow the group to substantially increase its destructive and disruptive capabilities (see Chapter 7). It is unknown to what extent they believed rockets might do the same.
[212] Having been given the cyanide, the CSA did not have to assess how easy it would be to acquire. With respect to rockets, there is no available information (short of the fact that he chose this option), regarding how Ellison perceived the ease of acquiring rockets.

[213] There is no evidence as to the perception of the ease of acquisition of either cyanide or rockets. The way that Bruce Pierce almost casually described his plans with the cyanide suggests that he might have perceived its acquisition to be fairly easy, but this is far from conclusive.

[214] It can be argued by looking at Noble's statements (see Chapter 7) about how the CSA's leaders viewed the cyanide that the very fact that not much information was widely available about how to use cyanide to poison a water supply meant that the CSA was not aware of the difficulties involved and that this made them more likely than otherwise to adopt.

[215] It is unclear from the evidence whether the low degree of availability of information about cyanide might have had any effect on the desire to adopt.

[216] The medium *techne* required for cyanide most likely did not affect the CSA's decision whether or not to adopt it. The high *techne* required for rockets, while during Phase II might not have affected the decision, during Phase III, when the CSA was attempting a variety of tactics, might very well have stimulated Ellison to attempt to adopt these weapons.

[217] There is no indication that the Order was particularly attracted towards a challenge, which would imply that the higher *techne* requirements would be discouraging.

[218] Once the science behind cyanide's toxicity is well-understood (for example, the dilution factor), the actual dissemination through a water supply is not too complex. The *mētis* required for developing and using rockets is substantial.

[219] Cyanide was widely available commercially and not overly expensive, whereas either buying rockets on the open market or assembling the materials and equipment to produce them in-house, would require fairly substantial financial resources, at the time probably running from several hundred to several thousand dollars.

[220] The effectiveness of a cyanide weapon depends to a large extent on the amount of agent and where it is inserted, which are not scalable. Machining and producing rockets does lend itself to economies of scale.

[221] Cyanide itself is readily trialable (as shown in the case of al-Qa'ida's testing on small mammals in Afghanistan). However, the dissemination with the intended outcome being mass-casualties through the water supply is more difficult, although a competent chemist could conceivably test concentrations in a small-scale model if the size of the target reservoir and the type of treatment is known beforehand. With respect to rockets, in terms of internal development, trialability is relatively low – one has to commit to quite a lot of investment before being able to fire the first shot. A ready-made, commercial system is readily trialable though.

[222] In the case of both cyanide and rockets, even though there were members of or artefacts in their milieu which endorsed these agents, none of these (neither the right-wing leaders nor the *Turner Diaries*) provided any tangible assistance in doing so.

[223] At its founding, most of the members of the Order lived within a few hundred miles of each other in the Pacific Northwest, although even at this stage, there were some members based as far away as the Central Coast of California and even in Pittsburgh. By Phase II, when the group became less centralized in structure, members were even more spread out.

[224] The action orientation of Mathews and most of the rest of the Order could be expected to make them less patient with longer-term acquisition or development projects, which is generally detrimental to prospects for success. This would only have been exacerbated by Mathews' increasing recklessness in Phase II.

[225] The models followed by Mathews (primarily the *Turner Diaries*) would not provide any tangible help or hindrance in adopting either weapon.

[226] Although some members of the group were extremely determined – including Mathews, Pierce, Scutari and Lane – others were more equivocal, such as Loff, Soderquist, Yarbrough and Rader. The determined sub-group would often keep trying until they succeeded (e.g., with armed robberies), but the less determined group would sometimes give up or only engage half-heartedly in their tasks.

[227] Since the commercial availability was only partial or limited, these factors receive a reduced score.

[228] By the early to mid-1980s, cyanide had been used in multiple applications as a poison (both of animals and people) for many years, whereas rockets had been in wide use by militaries for several decades.

Appendix C: Illustrative Application of the Weapons Adoption Model

The tables below represent the application of the Terrorist Weapons Adoption Model (as revised in Chapter 8) to three terrorist organizations (al-Qa'ida central, Hizb'allah, and an apocalyptic-millenarian cult modelled on Aum Shinrikyo) and two emerging technologies (chemical microreactors and rapid prototyping), as well as improvised explosive devices. For the purposes of this application, the '+'s and '–'s are represented by their numerical equivalent, i.e., '1', '2', '-1', '-2', etc.

Table C.1: Model Factors and Values[1]

Factors	Values		
	AQ Central	Hizb'allah	Apocalyptic Cult
SOCIETY			
Developed Infrastructure	No	No	Yes
Social / Political Openness	No	No	Yes
Intense Security Pressure	Yes	No	No
SOCIAL NETWORKS			
Highly Networked (in general)	No	Yes	No
Highly Networked (with other violent non-state actors)	Yes	No	No
Demonstration – 1st degree (by an actor in its own network)	IED: Yes ; MR-C: No ; RP: No	IED: Yes; MR-C: No; RP: No	IED: No ; MR-C: No ; RP: No
Cultural Affinity (homophily) with Relevant Network Node	IED: Yes ; MR-C: NA ; RP: NA	IED: Yes ; MR-C: NA ; RP: NA	IED: NA ; MR-C:NA ; RP:NA
Proselytization (change agents / opinion leaders)	IED: No ; MR-C: Unknown ; RP: Unknown	IED: No ; MR-C: Unknown ; RP: Unknown	IED: No; MR-C: No ; RP: No
State Sponsorship	Somewhat	Yes	No
Serendipitous Acquisition	IED: No ; MR-C: No; RP: No	IED: No ; MR-C: No; RP: No	IED: No ; MR-C: No; RP: No
Intergroup Competition	Yes (partial)	No	Yes
PRIOR ADOPTION (Outside the Organization)			

[1] Throughout these tables, 'IED' refers to improvised explosive devices, 'MR-C' refers to chemical microreactors, and 'RP' refers to rapid prototyping.

Demonstration – 2nd degree (by an actor out of its network)	IED: Yes ; MR-C: No ; RP: No	IED: Yes ; MR-C: No ; RP: No	IED: Yes ; MR-C: No ; RP: No
No. of Successful Prior Adopters [Linear]	IED: Many ; MR-C: None; RP: None	IED: Many ; MR-C: None; RP: None	IED: Many ; MR-C: None; RP: None
ORGANIZATIONAL CHARACTERISTICS			
History			
Age of Group (more than 5 years or not)	Yes	Yes	No
Prior Autarkic Technology Adoption	No	Yes	No
Prior Technology Adoption Outcomes	NA	Success	NA
Momentum	IED: Yes ; MR-C: No ; RP: No	IED: Yes ; MR-C: No ; RP: No	IED: No ; MR-C: No ; RP: No
Structure / Group Dynamics			
Size	Medium	Large	Small
Size of Talent Pool (with Techne & Mētis)	IED: Medium ; MR-C: Small; RP: Small	IED: Large ; MR-C: Unknown; RP: Medium	IED: Small ; MR-C: Small ; RP: Small
Centralization	High	Medium-High	High
Spatial Proximity of Organization Elements	Medium	Medium	High
Learning Organization	Unknown	Yes	No
Possesses Institutionalized R&D / "Skunkworks"	Unknown	Yes	Yes
Cohesiveness (lack of intragroup competition)	Medium	Medium-High	Medium
Resources			
Organizational Techne (Similar Technologies to Weapon)	IED: High; MR-C: Unknown; RP: Medium	IED: High; MR-C: Medium ; RP: High	IED: Medium; MR-C: Medium; RP: High
Organizational Mētis	IED: High; MR-C: Low; RP: Low	IED: High; MR-C: Low; RP: Unknown	IED: Low; MR-C: Low ; RP: Low
Org. Knowledge Type Ratio	IED: Med; MR-C: Unknown; RP: Medium-High	IED: Medium; MR-C: Medium-High; RP: Unknown	IED :Medium-High; MR-C: Medium-High; RP: High
General Tradecraft	Medium	High	Low
Safe Haven	Yes (partial)	Yes	No
Surfeit of Resources (esp. financial)	No	Yes	Yes
Access to Training Programs	No	Yes	Yes
Decision Making Characteristics			
Cognitive and Related Biases	Yes	No	Yes
Follow-The-Leader Bias (prior technology leader)	No	No	No

Disposed Toward Innovation	Partial	Partial	Yes
Disposed Away From Innovation	No	No	No
Affinity for the Weapon/Technology	IED: No ; MR-C: No; RP: No	IED: No; MR-C: No; RP: No	IED: No; MR-C: Yes; RP: No
Ideological/Cultural Compatibility with Technology	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: Yes; RP: Yes
Perception of Extreme Urgency (limited time to act)	No	No	Yes
Champion in Leadership	No	Unknown	Yes
Veto Players Exist Within Leadership Structure	Unknown	Yes	No
Guardians of Status Quo [Linear]	Unknown	Yes	No
Multiple Weapons Needed/Desired	IED: Yes ; MR-C: No; RP: Unknown	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: No; RP: Yes
Risk Tolerance	High	Medium	High
Desire for Prestige	High	High	Low
Determination	Yes	Partial	Yes
Strategic Dynamics			
Active Searching	IED: No; MR-C: Unknown; RP: Unknown	IED: No; MR-C: Unknown; RP: Yes	IED: No; MR-C: Yes; RP: No
Δ Status Quo Needed: Overcome Countermeasures	Yes	No	No
Δ Status Quo Needed: Overcome Desensitized Public	Yes	No	Yes
Perceived Advantages of Technology (vis-à-vis SQ)	IED: NA; MR-C: High; RP: High	IED: NA; MR-C: Medium; RP: High	IED: Medium ; MR-C: High; RP: High
Compatibility between Strategy and Technology	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: Yes; RP: Yes	IED: No; MR-C: Yes; RP: Unknown
Perception of Ease of Acquisition / Feasibility	IED: High; MR-C: Unknown; RP: Unknown	IED: High ; MR-C: High; RP: Medium	IED: Unknown; MR-C: Unknown; RP: High
Availability of alternatives to weapons technology under consideration	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: Yes; RP: Yes	IED: Yes; MR-C: Yes; RP: Yes

WEAPON CHARACTERISTICS	IEDS	Microreactors	Rapid Prototyping
Information Availability Relative to the Entire Technology	Medium	High	Medium
Weapon Techne	Medium	High	Medium
Weapon Mētis	High	Low	High
Knowledge Type Ratio (Techne/Mētis Required to Field Weapon)	Low-Med	High	Low-Med

Ease of Acquisition	High	Medium-High	Medium-High
Commercialized Technology	No	Yes	Yes
Financial Acquisition Cost	Low	Medium	Medium
Technology Lifecycle	Late	Early	Early
Economies of Scale	No	Yes	Yes
Trialability of Technology	High	Moderate	Moderate
Observability of Technology	High	Low	Low
Life Span of Technology	Medium	High	Medium-High
Stability of Technology	Medium	Medium-High	Medium
Environmental Persistence of Technology	Low	Medium	Low
Active Opposition of Possessors of Technology	Yes	No	No

Table C.2: Awareness Scores

Weapon / Technology Awareness			
	AQ Central	Hizb'allah	Apocalyptic Cult
SOCIETY			
Developed Infrastructure	0	0	2
Social / Political Openness	0	0	2
Intense Security Pressure	-1	0	0
SOCIAL NETWORKS			
Highly Networked (in general)	0	1	0
Highly Networked (with other violent non-state actors)	2	0	0
Demonstration – 1st degree (by an actor in its own network)	IED: 2; MR-C:0; RP:0	IED: 2; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Proselytization (change agents / opinion leaders)	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
State Sponsorship	0	1	0
Serendipitous Acquisition	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
PRIOR ADOPTION (Outside the Organization)			
Demonstration – 2nd degree (by an actor out of its network)	IED: 1; MR-C:0; RP:0	IED: 1 ; MR-C:0; RP:0	IED: 1; MR-C:0; RP:0
No. of Successful Prior Adopters [Linear]	IED: 2; MR-C: 0; RP: 0	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0
ORGANIZATIONAL CHARACTERISTICS			

History			
Prior Autarkic Technology Adoption	0	1	0
Prior Technology Adoption Outcomes	0	2	0
Structure / Group Dynamics			
Size	0	1	0
Size of Talent Pool (with Techne & Mētis)	IED:0.5; MR-C:0; RP:0	IED:1; MR-C:0; RP:0.5	IED:0; MR-C:0; RP:0
Centralization	0	0	0
Learning Organization	0	2	0
Possesses Institutionalized R&D / "Skunkworks"	0	3	3
Resources			
Organizational Techne (Similar Technologies to Weapon)	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:1	IED:0; MR-C:0; RP:1
Organizational Mētis	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Safe Haven	1	1	0
Surfeit of Resources (esp. financial)	0	1	1
Access to Training Programs	0	2	2
Decision-Making Characteristics			
Cognitive and Related Biases	0	0	0
Follow-The-Leader Bias (prior technology leader)	0	0	0
Disposed Toward Innovation	1	1	2
Disposed Away From Innovation	0	0	0
Affinity for the Weapon/Technology	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:1; RP:0
Ideological/Cultural Compatibility with Technology	IED:1; MR-C:1 ; RP:1	IED:1; MR-C:1; RP:1	IED:1; MR-C:1; RP:1
Perception of Extreme Urgency (limited time to act)	0	0	0
Guardians of Status Quo [Linear]	0	-1	0
Strategic Dynamics			
Active Searching	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:2	IED:0; MR-C:2; RP:0
Compatibility between Strategy and Technology	IED:1; MR-C:1; RP:1	IED:1; MR-C:1; RP:1	IED:0; MR-C:1; RP:0
SUBTOTAL:	**IED:12.5; MR-C:5; RP:5**	**IED:25; MR-C:17; RP:20.5**	**IED:16; MR-C:17; RP:14**

WEAPON / TECHNOLOGY CHARACTERISTICS	IEDS	Microreactors	Rapid Prototyping
Information Availability Relative to the Entire Technology	1	2	1
Commercialized Technology	0	1	1
Observability of Technology	2	-1	-1
Environmental Persistence of Technology	0	0	0
Active Opposition of Possessors of Technology	0	0	0
SUBTOTAL:	**3**	**2**	**1**
OVERALL TOTALS	**Weapon / Technology Awareness**		
	AQ Central	Hizb'allah	Apocalyptic Cult
IED	15.5	28	19
Chemical Microreactors	7	19	19
Rapid Prototyping	6	21.5	15

Table C.3: Decision Scores

Adoption Decision			
	AQ Central	Hizb'allah	Apocalyptic Cult
SOCIETY			
Developed Infrastructure	0	0	1
Intense Security Pressure	0	0	0
SOCIAL NETWORKS			
Demonstration – 1st degree (by an actor in its own network)	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Cultural Affinity (homophily) with Relevant Network Node	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Proselytization (change agents / opinion leaders)	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Serendipitous Acquisition	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Intergroup Competition	1	0	1
PRIOR ADOPTION (Outside the Organization)			
Demonstration – 2nd degree (by an actor out of its network)	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:0
No. of Successful Prior Adopters [Linear]	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0

ORGANIZATIONAL CHARACTERISTICS			
History			
Prior Autarkic Technology Adoption	0	IED:2; MR-C:1; RP:1	0
Prior Technology Adoption Outcomes	0	1	0
Momentum	IED:1; MR-C:0; RP:0	IED: 1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Structure / Group Dynamics			
Size	0	1	-1
Size of Talent Pool (with Techne & Mētis)	IED:0; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Centralization	0	0	0
Learning Organization	0	1	0
Possesses Institutionalized R&D / "Skunkworks"	0	2	2
Cohesiveness (lack of intragroup competition)	0	0	0
Resources			
Organizational Techne (Similar Technologies to Weapon)	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:2	IED:0; MR-C:0; RP:2
Organizational Mētis	IED:3; MR-C:-2; RP:-2	IED:3; MR-C:-2; RP:0	IED:-2; MR-C:-2; RP:-2
Org. Knowledge Type Ratio	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Safe Haven	0.5	1	0
Surfeit of Resources (esp. financial)	0	1	1
Access to Training Programs	0	1	1
Decision-Making Characteristics			
Cognitive and Related Biases	1	0	1
Follow-The-Leader Bias (prior technology leader)	0	0	0
Disposed Toward Innovation	1	1	3
Disposed Away From Innovation	0	0	0
Affinity for the Weapon/Technology	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:3; RP:0
Ideological/Cultural Compatibility with Technology	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Perception of Extreme Urgency (limited time to act)	0	0	IED:0; MR-C:-1; RP:-1
Champion in Leadership	0	0	IED:0; MR-C:3; RP:3
Veto Players Exist Within Leadership Structure	0	-1	0
Guardians of Status Quo [Linear]	0	0	0
Multiple Weapons Needed/Desired	IED:-1; MR-C:0; RP:0	IED:-1; MR-C:-1; RP:-1	IED:-1; MR-C:0; RP:-1

Risk Tolerance	1	0	1
Desire for Prestige	1	1	0
Strategic Dynamics			
Active Searching	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:2	IED:0; MR-C:2; RP:0
Δ Status Quo Needed: Overcome Countermeasures	2	0	0
Δ Status Quo Needed: Overcome Desensitized Public	2	0	1
Perceived Advantages of Technology (vis-à-vis SQ)	IED:0; MR-C:2; RP:2	IED:0; MR-C:0; RP:2	IED:1; MR-C:2; RP:2
Compatibility between Strategy and Technology	IED:1; MR-C:1; RP:1	IED:1; MR-C:1; RP:1	IED:0; MR-C:1; RP:0
Perception of Ease of Acquisition / Feasibility	IED:3; MR-C:0; RP:0	IED:3; MR-C:3; RP:1	IED:0; MR-C:0; RP:3
Availability of alternatives to weapons technology under consideration	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
SUBTOTAL:	**IED:25.5; MR-C:10.5; RP:10.5**	**IED:28; MR-C:11; RP:19**	**IED:12; MR-C:19; RP:17**
WEAPON CHARACTERISTICS	IEDS	Microreactors	Rapid Prototyping
Information Availability Relative to the Entire Technology	0	1	0
Weapon Techne	0	AQ:-1; Hizb:0; Apoc:0	0
Weapon Mētis	AQ:-1; Hizb:0; Apoc:0	AQ:1; Hizb:1; Apoc:1	AQ:-1; Hizb:0; Apoc:0
Knowledge Type Ratio (Techne/Mētis Required to Field Weapon)	0	2	0
Commercialized Technology	0	2	2
Financial Acquisition Cost	1	0	0
Economies of Scale	0	1	1
Trialability of Technology	2	0	0
Observability of Technology	1	-1	-1
Life Span of Technology	0	1	0
Stability of Technology	0	0.5	0
Environmental Persistence of Technology	0	0	0
Active Opposition of Possessors of Technology	-1	0	0
SUBTOTAL:	**AQ:2; Hizb:3; Apoc:3**	**AQ:6.5; Hizb:7.5; Apoc:7.5**	**AQ:1; Hizb:2; Apoc:2**

OVERALL TOTALS	**Decision**

	AQ Central	Hizb'allah	Apocalyptic Cult
IED	27.5	31	15
Chemical Microreactors	17	18.5	26.5
Rapid Prototyping	11.5	21	19

Table C.4: Success Scores

Adoption Success			
	AQ Central	Hizb'allah	Apocalyptic Cult
SOCIETY			
Developed Infrastructure	0	0	1
Social / Political Openness	0	0	1
Intense Security Pressure	-2	0	0
SOCIAL NETWORKS			
Highly Networked (in general)	0	1	0
Highly Networked (with other violent non-state actors)	2	0	0
Demonstration – 1st degree (by an actor in its own network)	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Cultural Affinity (homophily) with Relevant Network Node	IED:1; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Proselytization (change agents / opinion leaders)	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
State Sponsorship	1	2	0
Serendipitous Acquisition	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
PRIOR ADOPTION (Outside the Organization)			
No. of Successful Prior Adopters [Linear]	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:0
ORGANIZATIONAL CHARACTERISTICS			
History			
Age of Group (more than 5 years or not)	1	1	0
Prior Autarkic Technology Adoption	0	1	0
Prior Technology Adoption Outcomes	IED:0; MR-C:0; RP:0	IED:1; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Structure / Group Dynamics			

Size	0	1	0
Size of Talent Pool (with Techne & Mētis)	IED:0; MR-C:-1; RP:-1	IED:1; MR-C:0; RP:0	IED:-1; MR-C:-1; RP:-1
Centralization	1	0	1
Spatial Proximity of Organization Elements	0	0	1
Learning Organization	0	2	0
Possesses Institutionalized R&D / "Skunkworks"	0	2	2
Cohesiveness (lack of intragroup competition)	0	1	0
Resources			
Organizational Techne (Similar Technologies to Weapon)	IED:2; MR-C:0; RP:0	IED:2; MR-C:0; RP:2	IED:0; MR-C:0; RP:2
Organizational Mētis	IED:2; MR-C:-1; RP:-1	IED:2; MR-C:-1; RP:0	IED:-1; MR-C:-1; RP:-1
Org. Knowledge Type Ratio	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:-1
General Tradecraft	0	0	-1
Safe Haven	1	1	0
Surfeit of Resources (esp. financial)	0	1	1
Access to Training Programs	0	1	2
Decision-Making Characteristics			
Cognitive and Related Biases	-1	0	-2
Follow-The-Leader Bias (prior technology leader)	0	0	0
Ideological/Cultural Compatibility with Technology	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0	IED:0; MR-C:0; RP:0
Perception of Extreme Urgency (limited time to act)	0	0	-1
Veto Players Exist Within Leadership Structure	0	-1	0
Guardians of Status Quo [Linear]	0	-1	0
Multiple Weapons Needed/Desired	IED:-1; MR-C:0; RP: 0	IED:-2; MR-C:-2; RP:0	IED:-1; MR-C:0; RP:-1
Determination	2	1	2
Strategic Dynamics			
Compatibility between Strategy and Technology	IED:1; MR-C:1; RP:1	IED:1; MR-C:1; RP:1	IED:0; MR-C:1; RP:0
SUBTOTAL:	**IED:13; MR-C:4; RP:4**	**IED:22; MR-C:11; RP:16**	**IED:6; MR-C:6; RP:5**

WEAPON CHARACTERISTICS	IEDS	Microreactors	Rapid Prototyping
Information Availability Relative to the Entire Technology	0	1	0
Weapon Techne	0	-1	0

Weapon Mētis	-1	1	-1
Ease of Acquisition	2	1	1
Commercialized Technology	0	2	2
Financial Acquisition Cost [High]	1	0	0
Technology Lifecycle	1	0	0
Trialability of Technology	1	0	0
Observability of Technology	1	-1	-1
Stability of Technology	0	0.5	0
Active Opposition of Possessors of Technology	-1	0	0
SUBTOTAL:	**4**	**3.5**	**1**

OVERALL TOTALS	Success		
	AQ Central	Hizb'allah	Apocalyptic Cult
IED	17	26	10
Chemical Microreactors	7.5	14.5	9.5
Rapid Prototyping	5	17	6

Bibliography

Primary Material

Unpublished Primary Material

Official Documents

United States Federal Bureau of Investigation, *Information on the Covenant, the Sword and the Arm of the Lord* (2 July 1982). Declassified File No. 100-HQ-48720.[1]

United States Federal Bureau of Investigation, *Memorandum: SAC, Little Rock to Director, FBI* (24 August 1983). Declassified File No. 100-HQ-48720.

United States, no author listed, *Declassified Memorandum on the Covenant, the Sword and the Arm of the Lord* (Originating agency unidentified) dated 20 May 1985. Declassified on 28 September 1989.

United States of America, *Declassified Federal Bureau of Investigation Memorandum, Little Rock Office*, dated 2 July 1987.

United States of America v. James D. Ellison and William Thomas (CR85-20006), U.S. District court, Western District of Arkansas, Fort Smith Division.[2]

United States of America v. Stephen Scott (CR85-20014), U.S. District court, Western District of Arkansas, Fort Smith Division.

United States of America v. James D. Ellison and Kerry Noble (CR85-20015), U.S. District Court, Western District of Arkansas, Fort Smith Division.

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[1] Several internal Federal Bureau of Investigation documents relating to the CSA have been declassified through prior Freedom of Information Act requests. While some of these bear the declassification file number and date stamps, others merely consist of the original document. Most of these documents contain at least some redacted material.

[2] The author is indebted to Prof. Brent Smith and Paxton Roberts of the Terrorism Research Center at the University of Arkansas, for making available to the author all of the cited trial documents, which form part of the *American Terrorism Study* (see http://trc.uark.edu/index.php/rschProjects/1 for more details).

United States of America v. James D. Ellison and Kent Yates (CR85-20016), U.S. District Court, Western Arkansas District, Fort Smith Division.

United States of America v. James D. Ellison et. al. (CR85-20017), U.S. District Court, Western Arkansas District, Fort Smith Division.

United States of America, response to James D. Ellison's Motion for Reduction of Sentence (1988), *United States of America v. James D. Ellison* (CR85-20006-1 and CR85-20017-01), U.S. District court, Western District of Arkansas, Fort Smith Division.

United States of America v. Bruce Carroll Pierce et. al. (CR85-001M), U.S. District Court, Western District of Washington, Seattle Division.

United States of America v. Frank Silva (CR85-001M), U.S. District Court, Western District of Washington, Seattle Division.

United States of America v. Charles E. Ostrout (CR85-102-2), U.S. District Court, Northern District of California.

United States of America v. Ronald A. King et. al. (CR-85-0102), U.S. District Court, Northern District of California.

United States of America v. David Lane, et al (87-CR-114), U.S. District Court, District of Colorado, Denver Division.

United States of America v. Robert Edward Miles et. al. (CR87-20008), U.S. District court, Western District of Arkansas, Fort Smith Division.

<u>*Other Sources*</u>

Author interview with Jim Cusack, Dublin, Republic of Ireland, 20 June 2012.

Author interview with former Northern Ireland law enforcement official ‘A’, Belfast, Northern Ireland, 18 June 2012.

Author interview with former Northern Ireland law enforcement official ‘B’, Belfast, Northern Ireland, 18 June 2012.

Author interview with former Northern Ireland law enforcement official ‘C’, Belfast, Northern Ireland, 19 June 2012.

Author interview with former Northern Ireland law enforcement official ‘D’, Belfast, Northern Ireland, 19 June 2012.

Author Interview with Henry McDonald, Belfast, Northern Ireland, 19 June 2012.

Author interview with Shane Paul O’Doherty, Athlone, Republic of Ireland, 20 June 2012.

Author interview with Andy Oppenheimer, London, England, 22 June 2012.

Author’s personal correspondence with Dr. Michael Kenney, University of Pittsburgh (11 March 2013).

Author’s personal correspondence with Dr. Brian Jackson, RAND Corporation (16 May 2012).

McDonald, Henry, ‘Interview with Terry Robson’, conducted April 2-3, 1993. Held in the Northern Ireland Political Collection of the Linen Hall Library, Belfast, Northern Ireland.

Published Primary Material

Official Documents

Glover, J.M., *Northern Ireland Terrorist Trends* (London: Ministry of Defence, British

Government, 1978).

National Security Strategy of the United States (Washington, D.C.: White House, September 2002).

United States Attorney, Western District of Washington, *News Release* (15 April 1985).

United Nations General Assembly, *Report of the Secretary General on Chemical and Bacteriological (Biological) Weapons and the Effects of Their Possible Use*, UN Document A/7575 (1 July 1969).

Other Sources

Ackerman, Gary, *Testimony before United States Senate Committee on Homeland Security and Governmental Affairs*, Hearing on 'Nuclear Terrorism: Assessing the Threat to the Homeland' (2 April 2008), accessed at http://www.hsgac.senate.gov//imo/media/doc/040208Ackerman3.pdf on 2 November 2013.

Bradley, Gerry and Brian Feeney, *Insider: Gerry Bradley's Life in the IRA* (Dublin: The O'Brien Press, Ltd., 2009).

Collins, Eamon and Mick McGovern, *Killing Rage* (London: Granata Books, 1997).

Devalez, Olivier, 'A True Friend of Mine', in Magnus Söderman and Henrik Holappa (eds.), *Unbroken Warrior: The Richard Scutari Letters* (Stockholm: Nationellt Motständ Förlag, 2011), pp. 62-64.

Diodorus Sicilius, *Library of History Vol. VI*, translated by C. H. Oldfather (Cambridge, MA: Harvard University Press, 1954).

Holappa, Henrik, 'The Years with Richard Scutari: Foreward' in Magnus Söderman and Henrik Holappa (eds.), *Unbroken Warrior: The Richard Scutari Letters* (Stockholm: Nationellt Motständ Förlag, 2011), pp. 12-18.

Hunwick, John, *Timbuktu & the Songhay Empire: Al-Sa'dis Ta`rikh al-sudan down to 1613 and other Contemporary Documents* (Leiden: Brill, 1988).

McGuire, Eamon, *Enemy of the Empire: Life as an International Undercover IRA Activist* (Dublin: O'Brien Books, 2006).

No author listed, ‘Interview with Richard Scutari’, posted on *Stormfront.org*. Accessed at: http://www.stormfront.org/forum/t276328/ on 2 November 2013.

Noble, Kerry, *Tabernacle of Hate: Seduction into Right-Wing Extremism, 2nd ed.* (Syracuse, NY: Syracuse University Press, 2010).

O’Callaghan, Sean, *The Informer* (London: Corgi Books, 1999).

O’Doherty, Shane Paul, *The Volunteer: A Former IRA Man's True Story,* (Durham, CT: Strategic Books Group, 2011).

Scutari, Richard to Magnus Söderman (6 Apr. 2008) in Magnus Söderman and Henrik Holappa (eds.), *Unbroken Warrior: The Richard Scutari Letters* (Stockholm: Nationellt Motständ Förlag, 2011), pp. 32-33.

Scutari, Richard, quoted in Magnus Söderman, ‘Interview with Richard Scutari’, in Magnus Söderman and Henrik Holappa (eds.), *Unbroken Warrior: The Richard Scutari Letters* (Stockholm: Nationellt Motständ Förlag, 2011), pp. 103-126.

Slocum, S., ‘Extracts from the reports of Captain S L’H Slocum, Eighth Cavalry, on operations of the British Armey’ in *Boer War operations in South Africa 1899-1902*, The First Scripta Africana Series facsimile reproduction (Johannesburg: Scripta Africana, 1987).

Wellesley, Arthur to Henry Wellesley, October 3, 1802, in John Gurwood (ed.) *The Dispatches of Field Marshal the Duke of Wellington During His Various Campaigns in India, Denmark, Portugal, Spain, the Low Countries, and France, from 1799 to 1818*, Vols. I-II (London: John Murray, 1834).

Later Works

Books

Ackerman, Gary and Jeremy Tamsett, 'Introduction' in Gary Ackerman and Jeremy Tamsett (eds.), *Jihadists and Weapons of Mass Destruction* (Boca Raton, Florida: CRC Press, 2009), pp. xi-xxxiii.

Ackerman, Gary, 'Defining knowledge gaps within CBRN terrorism research', in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 13-26.

Agoston, Gabor, 'Behind the Turkish War Machine: Gunpowder Technology and War Industry in the Ottoman Empire 1450-1700' in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 101-136.

Alexander, Bevin, *The Future of Warfare* (New York: Norton Company, 1995).

Alexander, Yonah and John M.Gleason (eds.), *Behavioral and Quantitative Perspectives on Terrorism* (New York: Pergamon Press, 1981).

Arquilla, John, 'Patterns of Commercial Diffusion' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 348-371.

Arthur, Brian, *The Nature of Technology: What It Is and How It Evolves* (New York: Free Press, 2009).

Ayalon, David, *Gunpowder and Firearms in the Mamluk Kingdom* (London: Vallentine, 1956).

Bale, Jeffrey M. and Gary A. Ackerman, ‘Profiling the WMD Terrorism Threat’, in Stephen M. Maurer (ed.), *WMD Terrorism: Science and Policy Choices* (Cambridge, MA: MIT Press, 2009), pp. 11-46.

Bandura, Albert, ‘Mechanisms of Moral Disengagement’ in Walter Reich (ed.), *Origins of Terrorism: Psychologies, Ideologies, Theologies, States of Mind* (Washington, D.C.: Woodrow Wilson Center Press, 1998), pp. 161-191.

Barkun, Michael, *Religion and the Racist Right: The Origins of the Christian Identity Movement* (Chapel Hill: UNC Press, 1994).

Baumgartner, Frederick J., ‘The French Reluctance to Adopt Firearms Technology in the Early Modern Period’, in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 73-86.

Bloom, Mia, *Dying to Kill: The Allure of Suicide Terror* (New York: Columbia University Press, 2005).

Boot, Max. *War Made New: Technology, Warfare, and the Course of History, 1500 to Today* (New York, NY: Gothman Books, 2006).

Borowitz, Albert, *Terrorism for Self-Glorification: The Herostratos Syndrome* (Kent, OH: Kent State University, 2005).

Brodie, Bernard and Fawn M. Brodie, *From Crossbow to H-Bomb* (Bloomington, IN: Indiana University Press, 1973).

Brooks, John, *Dreadnought Gunnery and the Battle of Jutland* (New York: Routledge, 2005).

Brown, L. A., *Innovation Diffusion: A New Perspective* (New York: Methuen, 1981).

Bushart, Howard, John Craig and Myra Barnes, *Soldiers Of God: White Supremacists and Their Holy War for America* (New York: Kensington, 2000).

Buzan, Barry, *An Introduction to Strategic Studies: Military Technology and International Relations* (New York: St. Martin's Press, 1987).

Cameron, Gavin, *Nuclear Terrorism: A Threat Assessment for the 21st Century* (New York: Macmillan Palgrave, 1999).

Campbell, Duncan, *Greek and Roman Artillery 399 BC – AD 363* (Oxford: Osprey Publishing, 2003).

Carus, W. Seth, 'R.I.S.E.' in Jonathan Tucker (ed.), *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge, MA: MIT Press, 2000), pp. 55-70.

Chase, Kenneth, *Firearms: A Global History to 1700* (Cambridge: Cambridge University Press, 2003).

Chesbrough, Henry, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston: Harvard Business School Press, 2003).

Christensen, Clayton M., Erik A. Roth and Scott D. Anthony, *Seeing What's Next* (Boston: Harvard Business School Press, 2004).

Chyba, Christopher F. and Alex L. Greninger, 'Biotechnology and Bioterrorism: An Unprecedented World' in Russell D. Howard and James J.F. Forest (eds.), *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2008), pp. 198-211.

Clark, Richard C., *Technological Terrorism* (Greenwich, CT: Devon-Adair Pub, 1980).

Clutterbuck, Richard, 'Trends in Terrorist Weaponry' in Paul Wilkinson (ed.), *Terrorism and Technology* (Portland, Oregon: Frank Cass, 1993), pp. 130-139.

Coates, James, *Armed and Dangerous: The Rise of the Survivalist Right, 3rd ed.* (New York, NY: Hill and Wang, 1995).

Coogan, Tim P., *The IRA* (New York: Palgrave for St. Martin's Press, 2002).

Coulson, Danny and Elaine Shannon, *No Heroes: Inside the FBI's Secret Counter-Terror Force* (New York: Pocket Books, 1999).

Crenshaw, Martha, 'The Logic of Terrorism: Terrorist Behavior as a Product of Strategic Choice', in Walter Reich (ed.), *Origins of Terrorism: Psychologies, Ideologies, Theologies, States of Mind* (Washington, D. C.: Woodrow Wilson Center Press, 1998), pp. 7-24.

Crisp, Tom (ed.), *The Book of Bill: Choice Words, Memorable Men* (Kansas City, MI: Andrews McMeel Publishing, 2009).

Dees, Morris with James Corcoran, *Gathering Storm: America's Militia Threat* (New York, NY: Harper Perennial, 1997).

Demchak, Chris C., 'Creating the Enemy: Global Diffusion of the Information-Technology Based Military Model' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 307-347.

Devries, Kelly, 'Facing the New Technology: Gunpowder Defenses in Military Architecture before the *Trace Italienne* 1350-1500' in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 27-72.

Diamond, Jared, *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W. W. Norton & Co., 1999).

Diels, Hermann and Walther Kranz, *Die Fragmente der Vorsokratiker* (Zurich: Weidmann, 1985).

Dillon, Martin, *The Dirty War* (New York: Routledge, 1990).

Dolnik, Adam, *Understanding Terrorist Innovation: Technology, Tactics and Global Trends* (New York: Routledge, 2007).

Drake, C.J.M, *Terrorists' Target Selection* (New York: St. Martin's, 1998).

Dunnigan, James F., *Digital Soldiers: The Evolution of High-Tech Weaponry and Tomorrow's Brave New Battlefield* (New York: St. Martin's Griffin, 1998).

Dupuy, Trevor N., *The Evolution of Weapons and Warfare* (Cambridge, MA: Da Capo Press, 1990).

Eisenstadt, Michael J. and Kenneth Pollack, 'Armies of Snow and Armies of Sand: The Impact of Soviet Military Doctrine on Arab Militaries' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 63-92.

Eliason, Leslie and Emily Goldman, 'Introduction: Theoretical and Comparative Perspectives on Innovation and Diffusion', in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 1-32.

English, Richard, *Armed Struggle: The History of the IRA:* (Oxford: Oxford University Press, 2003).

Ferguson, Charles D., 'Influence Diagram Analysis of Nuclear and Radiological Terrorism' in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 122-138.

Festinger, Leon, Henry W. Riecken and Stanley Schachter, *When Prophecy Fails*

(London: Pinter and Martin, 2008).

Flynn, Kevin and Gary Gerhardt, *The Silent Brotherhood: Inside America's racist underground* (New York: Free Press, 1989).

Forest, James, 'Introduction' in James J. F. Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 1-32.

France, John, *Western Warfare in the Age of the Crusades, 1000-1300* (Ithaca, NY: Cornell University Press, 1999).

Freedman, Lawrence, *The Evolution of Nuclear Strategy* (London: St. Martin's Press, 1989).

Frieser, Karl-Heinz, *The Blitzkrieg Legend: The 1940 Campaign in the West* (Annapolis, MD: US Naval Institute Press, 2005).

Frontinus, *Strategems*, translated by Charles E. Bennett (Cambridge, MA: Harvard University Press, 1925).

George, Alexander L. and Andrew Bennett, *Case Studies and Theory Development in the Social Sciences* (Cambridge, Mass.: MIT Press, 2005).

Geraghty, Tony, *The Irish War: The Hidden Conflict Between the IRA and British Intelligence* (The Johns Hopkins University Press, 2000).

Gladwell, Malcolm, *The Tipping Point: How Little Things Can Make a Big Difference* (Boston: Back Bay Books, 2002).

Goldman, Emily O. and Andrew Ross, 'Conclusion: The Diffusion of Military Technology and Ideas—Theory and Practice' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 371-404.

Goldman, Emily O., ‘Receptivity to Revolution: Carrier Air Power in Peace and War’, in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 267-306.

Gray, Colin, *Strategy for Chaos: Revolutions in Military Affairs and the Evidence of History* (London: Frank Cass, 2002).

Guilmartin, John, *Gunpowder and Galleys: Changing Technology and Mediterranean Warfare at Sea in the Sixteenth Century*, Revised ed. (Annapolis, MD: Naval Institute Press, 2004).

Gurr, Nadine and Benjamin Cole, *The New Face of Terrorism: Threats from Weapons of Mass Destruction,* (New York: I. B. Tauris, 2002).

Hacker, Barton C., ‘Gunpowder and the Changing Military Order: The Islamic Gunpowder Empires ca. 1450 – ca. 1650’, in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 87-100.

Hall, Bert S., *Weapons and Warfare in Renaissance Europe* (Baltimore, MD: The Johns Hopkins University Press, 1997).

Hall, Bronwyn H. and Beethika Khan, *Adoption of New Technology* (Cambridge, MA: National Bureau of Economic Research, 2003).

Hamblin, Robert, R. Jacobson and J. Miller, *A Mathematical Theory of Social Change* (New York, NY: Wiley, 1973).

Hamm, Mark S., *Terrorism as Crime: From Oklahoma City to Al-Qaeda and Beyond* (New York: New York University Press, 2007).

Hamm, Mark, *Apocalypse in Oklahoma: Waco and Ruby Ridge revenged* (Lebanon, NH: Northeastern University Press, 1997).

Hammes, Thomas X., *The Sling and the Stone* (Minneapolis: Zenith Press, 2006).

Harding, David, *Weapons: An International Encyclopedia from 5000 B.C. to 2000 A.D.* (Darby, PA: Diane Publishing Company, 1990).

Hargadon, Andrew, *How Breakthroughs Happen: The Surprising Truth about How Companies Innovate* (Boston: Harvard Business School Publishing Corporation, 2003).

Harnden, Toby, *Bandit Country: The IRA and South Armagh* (London: Coronet Books, 2000).

Hayden, Nancy, 'Terrifying Landscapes: Understanding Motivations of Non-State Actors to Acquire and/or Use Weapons of Mass Destruction' in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 163-194.

Herrera, Geoffrey L. and Thomas G. Mahnken, 'Military Diffusion in Nineteenth Century Europe: The Napoleonic and Prussian Military Systems' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 205-242.

Hildred, Alexzandra, 'The Mary Rose: A Tale of Two Centuries' in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 137-180.

Hoddeson, Lillian, Paul W. Henriksen, Roger A. Meade and Catherine Westfall, *Critical Assembly: A Technical History of Los Alamos During the Oppenheimer Year, 1943-1945* (Cambridge, MA: Cambridge University Press, 1993).

Hoffman, Bruce, *Inside Terrorism* (New York: Columbia University Press, 2006).

Holland, Jack and Henry McDonald, *I.N.L.A: Deadly Divisions* (Dublin: Poolbeg Books, Ltd, 2010).

Holloway, David, *Stalin and the Bomb: The Soviet Union and Atomic* Energy, 1939-1956 (New Haven, CT: Yale University Press, 1996).

Homer-Dixon, Thomas, 'The Rise of Complex Terrorism' in Russell D. Howard and James J.F. Forest (eds.), *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2008), pp. 33-42.

Howard, Michael, 'Tools of War: Concepts and Technology' in J.A. Lynn (ed.), *Tools of War: Instruments, Ideas, and Institutions of Warfare, 1445-1871* (Urbana: University of Illinois Press, 1990), p. 238-248.

Hoyt, Timothy D., 'Revolution and Counter-Revolution: The Role of the Periphery in Technological and Conceptual Innovation', in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 179-204.

Jackson, Brian A. and David R. Frelinger, *Rifling through the Terrorists' Arsenal: Exploring Groups' Weapon Choices and Technology Strategies* (Santa Monica, CA: RAND, 2007).

Jackson, Brian A. et al, *Aptitude for Destruction-Vol. 2: Case Studies of Organizational Learning in Five Terrorist Groups* (Santa Monica: RAND, 2007).

Jackson, Brian A., et al, *Aptitude for Destruction-Vol. 1: Organizational Learning in Terrorist Groups and Its Implications for Combating Terrorism* (Santa Monica: RAND, 2007).

Jackson, Brian and Peter Chalk, et. al., *Breaching the Fortress Wall: Understanding Terrorist Efforts to Overcome Defensive Technologies* (Santa Monica, CA: RAND Corp., 2007).

Jones, Christopher, 'Reflections on Mirror Images: Politics and Technology in the arsenals of the Warsaw Pact' in Emily O. Goldman and Leslie C. Eliason (eds.), *The*

Diffusion of Military Technology and Ideas (Stanford: Stanford University Press, 2003), pp. 117-145.

Kaplan, David E., ‘Aum Shinrikyo (1995)’ in Jonathan Tucker (ed.), *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge, MA: MIT Press, 2000), pp. 207-226.

Kautilya, *Arthashastra,* Book XIV ‘Secret Means’, accessed from http://www.bharatadesam.com/literature/kautilya_arthashastra/arthashastra.php on 8 April 2009.

Keegan, John, *A History of Warfare* (New York: Vintage Books, 1993).

Kemp, Barry, *Ancient Egypt: Anatomy of a Civilization* (London: Routledge, 1983).

Kendall, Diana, Jane L. Murray and Rick Linden, *Sociology in Our Time* (Scarborough, ON: Nelson, 2000).

Kenney, Michael, *From Pablo to Osama* (University Park, PA: Penn State University Press, 2008).

King, Gary, Robert O. Keohane and Sidney Verba, *Designing Social Inquiry* (Princeton, NJ: Princeton University Press, 1994).

Kurzweil, Ray, *The Singularity is Near* (New York: Penguin Books, 2005).

Landes, David, *The Unbound Prometheus* (Cambridge: Cambridge University Press, 2003).

Larabee, Ann, ‘A Brief History of Terrorism in the United States’ in David Clarke (ed.), *Technology and Terrorism* (Somerset, NJ: Transaction Publishers, 2004), pp. 19-41.

Ley, Willey, *Rockets, Missiles, and Men in Space* (New York: Viking Press, 1968).

Lind, James, *A Treatise on the Scurvy* (London: A. Millar, 1753).

Lynn, John A., ‘Heart of the Sepoy’, in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), p. 33-62.

MacDonald, Andrew (aka William Pierce), *The Turner Diaries* ([Place of Publication Not Listed]: National Vanguard Books, 1978), downloaded from http://www.jrbooksonline.com/PDF_Books/TurnerDiaries.pdf on 19 November 2012.

Machiavelli, Niccolo, *Discourses on Livy* (1531), Book II, chapter 17, accessed from http://www.constitution.org/mac/disclivy_.htm on 19 April 2009.

MacKenzie, Donald, *Essays on Technical Change* (Cambridge: MIT Press, 1996).

Mahnken, Thomas, ‘Beyond Blitzkrieg’ in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 243-266.

Majahan, Vijay and Robert A. Peterson, *Models for Innovation Diffusion* (Newbury Park, CA: Sage Publications, Inc., 1985).

Malone, Patrick M., *The Skulking Way of War* (Lanham, MD: Madison Books, 2000).

Marighella, Carlos, *Minimanual of the Urban Guerrilla* (Montreal: Abraham Guillen Press, 2002 [originally published in 1960]).

Maurer, Stephen, ‘Introduction: Worrying about WMD Terrorism’, in Stephen M. Maurer (ed.), *WMD Terrorism: Science and Policy Choices* (Cambridge, MA: MIT Press, 2009), pp. 1-10.

Maurer, Stephen, ‘Technologies of Evil’ in Stephen M. Maurer (ed.), *WMD Terrorism: Science and Policy Choices* (Cambridge, MA: MIT Press, 2009), pp. 47-110.

Mauskopf, Seymour H., 'Chemistry in the Arsenal: State Regulations and Scientific Methodology of Gunpowder in Eighteenth Century England and France' in Brett D. Steele and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005), pp. 293-332.

McClellan, James Edward and Harold Dorn, *Science and Technology in World History: An Introduction*, 2nd Edition (Baltimore: Johns Hopkins University Press, 2006).

McNeill, William H., *The Pursuit of Power: Technology, Armed Force and Society since A.D.1000* (Chicago: University of Chicago Press, 1984).

Merriam-Webster Dictionary (Springfield, MA: Merriam Webster, 2004).

Miyamoto Musashi, *Book of Five Rings, Book of Earth*, accessed from http://www.miyamotomusashi.com/gorin.htm on 8 April 2009.

Mokyr, Joel, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton: Princeton University Press, 2002).

Mokyr, Joel, *The Lever of Riches* (New York: Oxford University Press, 1990).

Moloney, Ed, *A Secret History of the IRA* (New York: W.W. Norton & Company Ltd., 2002).

Morison, S. E., *William Bradford, Of Plymouth Plantation 1620-1647*, (New York, 1967).

Mullins, Wayman C., *A Sourcebook on Domestic and International Terrorism: An Analysis of Issues, Organizations, Tactics and Responses* (Springfield, IL: Charles C. Thomas Publisher, Ltd., 1997).

Murray, Williamson R. and Allan R. Millett (eds.), *Military Innovation in the Interwar Period* (Cambridge: Cambridge University Press, 1998).

Nafziger, George F. and Mark Walton, *Islam at War: A History* (Praeger Publishers, 2003).

No listed author, *Hate Groups in America: A Record of Bigotry and Violence* (New York, NY: Anti-Defamation League of B'nai B'rith, c. 1988).

O'Neil, Andrew, 'Terrorist Use of Weapons of Mass Destruction: How Serious is the Threat?' in Russell D. Howard and James J.F. Forest (eds.), *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2008), pp. 65-76.

O'Brien, Brendan, *The Long War: The IRA and Sinn Féin* (Syracuse: Syracuse University Press, 1999).

Oppenheimer, A.R., *IRA, The Bombs and the Bullets: A History of Deadly Ingenuity* (Dublin: Irish Academic Press, 2009).

Ortiz, Román D., 'Renew to Last: Innovation and Strategy of the Revolutionary Armed Forces of. Colombia (FARC)' in James J. F. Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 205-222.

Parker, Geoffrey. *The Military Revolution* (New York: Cambridge University Press, 2007).

Pierce, Terry, *Warfighting and Disruptive Technologies: Disguising Innovation* (New York: Routledge, 2004).

Potter, William, 'The Diffusion of Nuclear Weapons' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 146-178.

Ragin, Charles C., *Redesigning Social Inquiry: Fuzzy Sets and Beyond* (Chicago and London: University of Chicago Press, 2008).

Ramakrishna, Kumar, ‘The Making of the Jemaah Islamiyah Terrorist’ in James J. F. Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 223-260.

Ranstorp, Magnus and Magnus Normark, ‘Introduction’ in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 1-10.

Rhodes, Richard, *The Making of the Atomic Bomb* (New York: Simon and Schuster, 1986).

Ridgeway, James, *Blood in the Face: The Ku Klux Klan, Aryan Nations, Nazi Skinheads, and the Rise of a New White Culture* (New York: Thunder’s Mouth Press, 1995).

Rihoux, Benoît, and Charles Ragin (eds.), *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques* (Thousand Oaks, CA: Sage Publications, Inc., 2009).

Robb, John, *Brave New War: The Next Stage of Terrorism and the End of Globalization* (Hoboken, New Jersey: John Wiley & Sons, 2007).

Rogers, Clifford J., ‘The Military Revolutions of the Hundred Years’ War’ in Clifford J. Rogers (ed.), *The Military Revolutions Debate* (Westview Press, 1995).

Rogers, Everett, *Diffusion of Innovations,* 5th ed. (New York: Free Press, 2003).

Ronfeldt, David and William Sater, *The Mindsets of High-Technology Terrorists: Future Implications from an Historical Analog* (Santa Monica, CA: RAND, 1981).

Rosen, Steven Peter, *Innovation and the Modern Military: Winning the Next War* (Ithaca, NY: Cornell University Press, 1991).

Rosenfeld, Jean, ‘Introduction’ in Kerry Noble, *Tabernacle of Hate: Seduction into*

Right-Wing Extremism, 2nd ed. (Syracuse, NY: Syracuse University Press, 2010).

Ryder, Chris, *A Special Kind of Courage: 321 Squadron – Battling the Bombers* (London: Methuen, 2006).

Schencking, J. Charles, *Politics, Propaganda, and the Emergence of the Imperial Japanese Navy, 1868-1922* (Stanford: Stanford University Press, 2005)

Schmid, Alex P. and Albert J. Jongman, *Political Terrorism: A New Guide to Actors, Authors, Concepts, Data Bases, Theories and Literature* (Amsterdam: North-Holland, 1988).

Schmid, Alex P. and Janny de Graaf, *Violence as Communication: Insurgent Terrorism and the Western News Media* (Beverly Hills, CA: Sage Publications, 1982).

Shelley, Toby, *Nanotechnology: New Promises, New Dangers* (London: Zed Books, 2006)

Showalter, Dennis, 'Weapons and Ideas in the Prussian Army from Frederick the Great to Moltke the Elder' in J.A. Lynn (ed.), *Tools of War: Instruments, Ideas, and Institutions of Warfare, 1445-1871* (Urbana: University of Illinois Press, 1990), pp. 177-210.

Singular, Stephen, *Talked to Death: The Life and Murder of Alan Berg* (New York: Beech Tree Books, 1987).

Smith, Brent L., *Terrorism in America: Pipe Bombs and Pipe Dreams* (Albany: State University of New York Press, 1994).

Smith, G. Davidson, 'Sources of Terrorist Weaponry and Major Methods of Obtaining Weapons and Techniques' in Wilkinson (ed.), pp. 123-129.

Smith, M. R. and L. Marx (eds.), *Does Technology Drive History? The Dilemma of Technological Determinism* (Cambridge, MA, 1994).

Smith, M.L.R., *Fighting for Ireland?: The Military Strategy of the Irish Republican Movement* (London: Routledge, 1995).

Smithson, Amy E., 'Indicators of Chemical Terrorism' in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 67-94.

Sombart, Werner, *Krieg und Kapitalismus* (Munich: Duncker & Humblot, 1913).

Steele, Brett D. and Tamera Dorland (eds.), *The Heirs of Archimedes: Science and the Art of War Through the Age of Enlightenment* (Cambridge, MA: MIT Press, 2005).

Stenersen, Anne, 'Al-Qaeda's thinking on CBRN' in Magnus Ranstorp and Magnus Normark (eds.), *Unconventional Weapons and International Terrorism: Challenges and New Approaches* (New York: Routledge, 2009), pp. 50-64.

Stern, Jessica E., 'The Covenant, the Sword and the Arm of the Lord (1985)' in Jonathan Tucker (ed.), *Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons* (Cambridge, MA: MIT Press, 2000), pp. 139-158.

Stern, Jessica, *Terror in the Name of God: Why Religious Militants Kill* (New York: HarperCollins Publishers Inc., 2003).

Stevens, F.T., *Complete History of the South African War, 1899-1902* (London: W. Nicholson & Son, 1902).

Stolley, Paul and James Schlesselman, *Case-control studies: Design, Conduct, Analysis* (Oxford: Oxford University Press, 1982).

Strachan, Hew, 'The British Army and "Modern" War: The Experience of the Peninsula and of Crimea' in J.A. Lynn (ed.), *Tools of War: Instruments, Ideas, and Institutions of Warfare, 1445-1871* (Urbana: University of Illinois Press, 1990), pp. 211-237.

Strickland, Matthew and Robert Hardy, *The Great Warbow* (Stroud: Sutton Publishing, 2005).

Sun Tzu, *On the Art of War – Special Edition*, translated by Lionel Giles, edited by James H. Ford (El Paso Norte Press, 2005).

Tamsett, Jeremy and Gary Ackerman, 'Conclusion' in Gary Ackerman and Jeremy Tamsett (eds.), *Jihadists and Weapons of Mass Destruction* (Boca Raton, Florida: CRC Press, 2009), pp. 401-418.

Thucydides, *History of the Peloponnesian War*, translated by Thomas Hobbes (London: Bohn, 1843). Accessed from the Perseus Digital Library, Tufts University at www.perseus.tufts.edu.

Toffler, Alvin and Heidi Toffler, *War and Anti-War* (London: Warner Books, 1993).

Toolis, Kevin, *Rebel Hearts: Journeys Within the IRA's Soul* (New York: St. Martin's Press, 1995).

Trujillo, Horacio and Brian A. Jackson, 'Organizational Learning and Terrorist Groups' in James J. F. Forest (ed.), *Teaching Terror: Strategic and Tactical Learning in the Terrorist World* (Lanham, Maryland: Rowman and Littlefield, 2006), pp. 52-68.

Tsebelis, George, *Veto Players: How Political Institutions Work* (Princeton: Princeton University Press, 2002).

Turney-High, Harry H., *Primitive War: Its Practice and Concepts* (Columbia, SC: University of South Carolina Press, 1949).

Urban, Mark, *Big Boys' Rules: The Secret Struggle Against the IRA* (London: Faber & Faber, 1992).

Van Creveld, Martin, *Technology and War: From 2000 B.C. to the Present* (New York: The Free Press, 1991).

Van Evera, Stephen, *Guide to Methods for Students of Political Science* (Ithaca: Cornell University Press, 1997).

Volkman, Ernest, *Science Goes to War: The Search for the Ultimate Weapon, From Greek Fire to Star Wars* (New York, NY: John Wiley & Sons, 2002).

Von Braun, Wernher and Frederick I. Ordway III, *Rocketry and Space Travel*, 3rd ed. (New York: Crowell, 1975).

Wagner, Abraham R., 'Terrorist Use of New Technologies' in Peter Katona, Michael D. Intriligator and John P. Sullivan (eds.), *Countering Terrorism and WMD: Creating a Global Counterterrorism Network* (New York: Routledge, 2006), pp. 109-130.

Waller, Jr., Forest E. and Michael A. George, 'Emerging WMD Technologies', in Russell D. Howard and James J.F. Forest (eds.), *Weapons of Mass Destruction and Terrorism* (New York: McGraw-Hill, 2008), pp. 499-511.

Waltz, Kenneth N., *Theory of International Politics* (New York: McGraw-Hill, 1979).

Weigley, Russell F., *The Age of Battles: The Quest for Decisive Battles from Breitenfeld to Waterloo* (Bloomington: Indiana University Press, 1991).

Wells, H.G., *The World Set Free* (Hollywood: Leisure Books Inc, 1971 [1914]).

White, Lynn, *Medieval Technology and Social Change* (Oxford: Oxford University Press, 1962).

Wilkinson, Paul, 'Editor's Introduction' in Paul Wilkinson (ed.), *Terrorism and Technology* (Portland, Oregon: Frank Cass, 1993), pp. 1-11.

Young, Thomas-Durell, 'Cooperative Diffusion through Cultural Similarity: The Postwar Anglo-Saxon Experience' in Emily O. Goldman and Leslie C. Eliason (eds.), *The Diffusion of Military Technology and Ideas* (Stanford: Stanford University Press, 2003), pp. 93-116.

Zablocki, Benjamin and Thomas Robbins (eds.), *Misunderstanding Cults: Searching for Objectivity in a Controversial Field* (Toronto: University of Toronto, 2001).

Zilinskas, Raymond and Malcolm Dando, ‘Biotechnology and Bioterrorism’ in Raymond Zilinskas and Richard Pilch (eds.), *Encyclopedia of Bioterrorism Defense* (Hoboken, New Jersey: John Wiley & Sons, 2005), pp. 63-75.

Articles

Abrahamson, Eric, ‘Managerial Fads and Fashions: The Diffusion and Rejection of Innovations’, *The Academy of Management Review*, 16:3 (1991), pp. 586-612.

Ackerman, Gary, Victor Asal and Karl R. Rethemeyer, ‘Toxic Connections: Terrorist Organizational Factors and the Pursuit of Unconventional Weapons’, *Studies in Conflict and Terrorism*, 35:3 (2012), pp. 229-254.

Bale, Jeffrey M., ‘The Cult Wars, Part I’, *Hit List Magazine* 2:4 (November-December 2000), pp. 80-85.

Baptista, Rui ‘The Diffusion of Process Innovations: A Selective Review’, *International Journal of the Economics of Business*, 6:1 (1999), pp. 107-129.

Barkun, Michael, ‘Millenarian Aspects of “White Supremacist” Movements’, *Terrorism and Political Violence*, 1:4 (1989), pp. 409-434.

Barkun, Michael, ‘Religion, Militias and Oklahoma City: The Mind of Conspiratorialists’, *Terrorism and Political Violence*, 8:1 (1996), pp. 50-64.

BBC News, ‘Who are the INLA?’ 14 September 2010. Accessed at: http://www.bbc.co.uk/news/uk-northern-ireland-11090412 on 10 October 2013.

Bell, J. Bowyer, ‘Trends on Terror: The Analysis of Political Violence’, *World Politics*

29:3 (April 1977), pp. 476-488.

Bennett, Colin J., ‘Review Article: What is Policy Convergence and What Causes It?’, *British Journal of Political Science,* 21:2 (1991), pp. 215-233.

Bennett, Matthew, ‘The Crusaders’ “Fighting March” Revisited’, *War in History* 8:1 (2000), pp. 1-18.

Black, Jeremy, ‘Determinisms and Other Issues’, *Journal of Military History*, 68:4 (2004), pp. 1217-1232.

Boyne, Sean, ‘Uncovering the Irish Republican Army: Organization’, *Jane's Intelligence Review* (1 August 1996). Accessed at: http://www.pbs.org/wgbh/pages/frontline/shows/ira/inside/org.html on 6 October 2013.

Boyne, Sean, ‘Uncovering the Irish Republican Army: Weapons’, *Jane's Intelligence Review,* 1 August 1996, accessed at http://www.pbs.org/wgbh/pages/frontline/shows/ira/inside/weapons.html on 6 October 2013.

Bryant, G. J., ‘Asymmetric Warfare: The British Experience in Eighteenth-Century India’, *Journal of Military History*, 68:2 (April 2004), pp. 431-469.

Byman, Daniel, ‘Iran, Terrorism, and Weapons of Mass Destruction’, *Studies in Conflict & Terrorism*, 31:3 (2008), pp. 169-181.

Cameron, Gavin, ‘Multi-track Microproliferation: Lessons from Aum Shinrikyo and Al Qaida’, *Studies in Conflict and Terrorism* 22:4 (November 1999), pp. 277-309.

Coaffee, Jon, ‘Rings of Steel, Rings of Concrete and Rings of Confidence: Designing Out Terrorism in Central London Pre and Post September 11th’, *International Journal of Urban and Regional Research*, 28:1 (2004), pp. 201-211.

Cowan, Robin and Dominique Foray, ‘The Economics of Codification and the

Diffusion of Knowledge', *Industrial and Corporate Change*, 6:3 (1997), pp. 595-622.

Cusack, Jim, 'INLA Man Feigned Friendship but Ordered my Death', *Independent* (12 August 2007). Accessed at: http://www.independent.ie/opinion/analysis/inla-man-feigned-friendship-but-ordered-my-death-1056983.html on 10 October 2013.

Cusack, Jim, 'IRA –INLA Clash over Fund Raising Issues', *Irish Times* (26 July 1984), p. unknown.

Danneels, Erwin, 'Disruptive Technology Reconsidered: A Critique and Research Agenda', *Journal of Product Innovation Management*, 21 (2004), pp. 246-258.

De Solla Price, Derek J. and Donald Deb Beaver, 'Collaboration in an Invisible College', *American Psychologist,* 21:11 (1966), 1011-1018.

Detwarasiti, Apiruk and Ross D. Shachter, 'Influence Diagrams for Team Decision Analysis', *Decision Analysis* 2:4 (December 2005), pp. 207-228.

DiMaggio, Paul J. and Walter W. Powell, 'The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields', *American Sociological Review*, 48 (1983), pp. 147-160.

Dugan, Laura, Gary Lafree and Alex Piquero, 'Testing a Rational Choice Model of Airline Hijackings', *Criminology*, Volume 43 (2005), pp. 1031-1066.

Dunn, Ashley, 'Mathews had a History of Rightwing Fanaticism', *Seattle Post-Intelligencer* (10 Dec.1984), p. A-8.

Elkus, Adam, 'Night of the Lone Wolves' *Defense and National Interest* (28 November 2007), accessed at: http://www.dnipogo.org/fcs/elkus_lone_wolves.htm on 2 November 2013.

Flaherty, Joseph, 'Looks Could Kill: Using 3-D Printers to Design Guns', *Wired* (20 August 2012), accessed at: http://www.wired.com/design/2012/08/rapid-fire-rapid-prototypes/ on 2 November 2013.

Freeman S., and B. Penrose, ‘INLA muscles in on rackets’, *Sunday Times – London* (17 June 1984), p. 1.

Gefang Wang, et. al., ‘Application of Rapid Prototyping Technology in Equipment Parts Rapid Manufacturing’, *3rd International Conference on System Science, Engineering Design and Manufacturing Informatization*, 2012, accessed at: http://ieeexplore.ieee.org/xpl/abstractAuthors.jsp?tp=&arnumber=6340744&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6340744, on 2 November 2013.

Gleick, Peter H., ‘Water and terrorism’, *Water Policy* 8 (2006), pp. 481–503.

Gopalakrishnan, Shanti and Paul Bierly, ‘Analyzing Innovation Adoption Using a Knowledge-Based Approach’, *Journal of Engineering and Technology Management*, 18 (2001), pp. 107-130.

Granovetter, Mark S., ‘The Strength of Weak Ties’, *American Journal of Sociology*, 78:6 (May 1973), pp. 1360-1380.

Gressang IV, Daniel, ‘Audience and Message: Assessing Terrorist WMD Potential’, *Terrorism and Political Violence* 13:3 (Fall 2001), pp. 83-106.

Hagel, John, John Brown and Lang Davison, ‘Shaping Strategy in a World of Constant Disruption’, *Harvard Business Review* 85:10 (October 2008), pp. 81-90.

Horgan, John and Max Taylor, ‘The Provisional Irish Republican Army: Command and Functional Structure’, *Terrorism and Political Violence,* 9:3 (1997), pp. 1-32.

Isenberg, Daniel J., ‘Group Polarization: A Critical Review and Meta-Analysis’, *Journal of Personality and Social Psychology*, 50:6 (1986), 1141-1151.

Jackson, Brian A., ‘Technology Acquisition by Terrorist Groups: Threat Assessment

Informed by Lessons from Private Sector Technology Adoption', *Studies in Conflict and Terrorism*, 24:3 (May 2001), pp. 183-213.

Jackson, Camille, 'The Turner Diaries, Other Racist Novels, Inspire Extremist Violence', *Southern Poverty Law Center Intelligence Report*, 115 (Fall 2004), accessed at: http://www.splcenter.org/get-informed/intelligence-report/browse-all-issues/2004/fall/fightin-words on 2 November 2013.

Jenkins, Brian, 'Defense Against Terrorism', *Political Science Quarterly 101, Reflections on Providing for "The Common Good,"* 101:5 (1986), pp. 773-786.

Kahneman, Daniel and Amos Tversky, 'Prospect Theory: An Analysis of Decision under Risk', *Econometrica*, XLVII (1979), pp. 263-291.

Kenney, Michael, ' "Dumb" Yet Deadly: Local Knowledge and Poor Tradecraft Among Islamist Militants in Britain and Spain', *Studies in Conflict & Terrorism*, 33:10 (2010), pp. 911-932.

Killigrew, John W., 'Reviewed work: Chung-kuo Ku-ping-ch'i t'ao-lun [A Discussion of Ancient Chinese Military Equipment] by Yang Hung' *Military Affairs*, 46:1 (February 1982), pp. 46-47.

Lacy, Michael G., 'Efficiently Studying Rare Events: Case-Control Methods for Sociologists', *Sociological Perspectives*, 40:1 (1997), pp. 129-154.

Lambert, Nicholas A., ' "Our Bloody Ships" or "Our Bloody System"? Jutland and the Loss of the Battle Cruisers, 1916', *Journal of Military History*, 62:1 (Jan. 1998), pp. 29-55.

Leitenberg, Milton, 'Aum Shinrikyo's Efforts to Produce Biological Weapons: A Case Study in the Serial Propagation of Misinformation', *Terrorism and Political Violence* 11:4 (Winter 1999), pp. 149-158.

Levitt, Barbara and James G. March, 'Organizational Learning', *Annual Review of*

Sociology 14 (1988), pp. 319-340.

Lewis, Peter and Joni Balter, ‘Whidbey Siege: Roles in a Book?’, *Seattle Times* (10 Dec. 1984), p. A1

Lu Gwei-Djen, Joseph Needham, and Phan Chi-Hsing, ‘The Oldest Representation of a Bombard’, *Technology and Culture*, 29:3 (July 1988), pp. 594-605.

Majchrzak, Ann, et al, ‘Technology Adaptation: The Case of Computer-Supported Inter-Organizational Virtual Teams’, *MIS Quarterly*, 24:4 (2000), pp. 569-600.

Mallett, M.E., ‘Diplomacy and war in later fifteenth-century Italy,’ *Proceedings of the British Academy*, LXVII (1981), pp. 267-288.

Mao Ying, ‘Introduction of Crossbow Mechanism’, *Southeast Culture*, No. 3 (1998), pp. 109-117.

Mathews, Robert, [Untitled Poem], *White American Resistance*, 4:2 (1985), p. 5.

McCormick, Gordon H., ‘Terrorist Decision Making’, *Annual Reviews in Political Science* 6 (2003), pp. 473-507.

McDonald, Henry, ‘Terrorists Reach the Crossroads’, *The Observer*, 16 October 1999. Accessed at: http://www.guardian.co.uk/uk/1999/oct/17/northernireland.theobserver on 10 October 2013.

Metz, Steven, ‘A Wake for Clausewitz: Toward a Philosophy of 21st-Century Warfare’, *Parameters*, 24 (Winter 1994-95), pp. 126-132.

Mills, Patrick L., David J. Quiram and James F. Ryley, ‘Microreactor Technology and Process Miniaturization for Catalytic Reactions—A Perspective on Recent Developments and Emerging Technologies’, *Chemical Engineering Science* 62 (2007), pp. 6992-7010.

Mooney, John, ‘Dissident Republicans Linked to Dublin Pipe Bombs’, *Sunday Times, London* (June 1, 2008), p.8.

Morlin, Bill, ‘FAA Brings Action Against Two-Plane “Aryan Air Force”’, *Spokane Chronicle* (4 March 1985), pp. 1-5.

Nguyen, Tuan H., ‘Microchallenges of Chemical Weapons Proliferation’, *Science*, 309:5737 (12 August 2005), p. 1021.

No author listed, ‘Poison Is Suspected in Death of 30 Cows on a Muslim Farm’, *New York Times* (16 March 1970), p. 30.

No author listed, ‘In the Irish Republic, Five Hooded Gunmen Bombed a Government Radar Station’, *The Telegraph* (21 September 1982).

No author listed, ‘INLA’s New Threat to NATO’, *Sunday World* (3 February 1985), p. unknown.

No author listed, ‘The McGlinchey File’, *New Hibernia*, 3 (October 1985), p. 3.

No author listed, ‘The INLA Devours Itself’, *Magill,* 10:7 (March 1987), pp. 16-26.

No author listed, ‘Group Weighed Cyanide Assault, Witness Testifies’, *Birmingham News* (23 February 1988), p. 6.

No author listed, ‘Northern Ireland; IRA Guerrillas Attack Army Post’, *St. Louis Post-Dispatch* (25 February 1991), p. A8.

No author listed, ‘Interview with Dr. Sanjay Gupta: Cyanide poison hard to detect’, CNN (10 January 2003), accessed at http://articles.cnn.com/2003-01-10/us/otsc.gupta.cyanide_1_potassium-cyanide-benjamin-vassiliev-ryan-furlough?_s=PM:US on 26 October 2013.

No author listed, ‘INLA Decommissions Weapons After 35-year Irish Terror Campaign that Cost 100 Lives Including MP Airey Neave', *Daily Mail Reporter* (8 February 2010). Accessed at: http://www.dailymail.co.uk/news/article-1249365/Irish-National-Liberation-Army-Terror-group-murdered-Airey-Neave-decommissions-weapons.html on 11 October 2013.

No author listed, 'Cotton fabric cleans itself when exposed to ordinary sunlight', *Phys.Org News* (14 Dec 2011). Accessed at http://phys.org/news/2011-12-cotton-fabric-exposed-ordinary-sunlight.html on 10 October 2013.

Palfy, Arpad, 'Weapon System Selection and Mass-Casualty Terrorism', *Terrorism and Political Violence*, 15 (2003), pp. 81-95.

Pankratz, Howard, 'Blast Blamed on Revenge Attack Linked to Militant's Execution', *Denver Post* (12 May 1996), p. A-1.

Petras, J. and M. Zeitlin, 'Miners and Agrarian Radicalism', *American Sociological Review,* 32 (1967), pp. 578-586.

Post, Jerrold M., Kevin G. Ruby and Eric D. Shaw, 'The Radical Group in Context: 1. An Integrated Framework for the Analysis of Group Risk for Terrorism', *Studies in Conflict & Terrorism*, 25:2 (2002), pp. 73-100.

Post, Jerrold, Ehud Sprinzak and Laurita Denny, 'The Terrorists in their Own Words: Interviews with 35 Incarcerated Middle Eastern Terrorists', *Terrorism and Political Violence*, 15:1 (2003), pp. 171-184.

Powell, Walter W., 'Neither Market nor Hierarchy: Network Forms of Organization', in Barry M. Staw and L.L. Cummings (eds.), *Research in Organizational Behavior 12* (Greenwich, Connecticut: JAI Press, 1990), pp. 295-336.

Pynchon, Marisa Reddy and Randy Borum, 'Assessing Threats of Targeted Group Violence: Contributions from Social Psychology', *Behavioral Sciences and the Law* 17 (1999), pp. 339-355.

Resende-Santos, Joao, ‘Anarchy and Emulation of Military Systems: Military Organizations and Technology in South America, 1870-1930’, *Security Studies* 5:3 (Spring 1996), pp. 193-260.

Rimer, Sara, ‘Cyanide Purchase is Linked to Death in Nashville’, New York Times (1 March 1986). Accessed at http://www.nytimes.com/1986/03/01/us/cyanide-purchase-is-linked-to-death-in-nashville.html on 26 October 2013.

Robinson, David, Grant Savage, and Kim Campbell, ‘Organizational Learning, Diffusion of Innovation, and International Collaboration in Telemedicine’, *Health Care Management Review*, 28:1 (2003), pp. 68-78.

Romme, Georges and Ron Dillen, ‘Mapping the Landscaping of Organizational Learning’, *European Management Journal,* 15:1 (1997), pp. 68-78.

Routledge, Paul, ‘The Day I Met Airey Neave’s Killers’, *Mail On Sunday,* Morning Section (3 March 2002), p. 47.

Ryan, Bryce, ‘A Study in Technological Diffusion’, *Rural Sociology*, 13 (1948), pp. 273-285.

Schaefer, David, ‘Fiery FBI Raid End Whidbey Standoff’, *Seattle Post-Intelligencer* (9 Dec. 1984), p. A1.

Schweiger, David, Tugrul Atamer and Roland Calori, ‘Transnational Project Teams and Networks: Making the Multinational Organization More Effective,’ *Journal of World Business*, 38 (2003), pp. 127-140.

Soedel, Werner and Vernard Foley, ‘Ancient Catapults’, *Scientific American* (1979), pp. 150–60.

Stone Jr., J.L., ‘Irish Terrorism Investigations’, *FBI Law Enforcement Bulletin* (October 1987), pp. 22-23.

Strang, David and John Meyer, ‘Institutional Conditions for Diffusion’, *Theory and*

Society, 22 (1993), pp. 487-511.

Strang, David and Michael W. Macy, ‘In Search of Excellence: Fads, Success Stories, and Adaptive Emulation’, *American Journal of Sociology,* 107 (2001), pp. 147-182.

Strang, David and Sarah Soule, ‘Diffusion in Organizations and Social Movements: From Hybrid Corn to Poison Pills’, *Annual Review of Sociology*, 24 (1998), pp. 265-290.

Tarrow, Sidney, ‘The Strategy of Paired Comparison: Toward a Theory of Practice’, *Comparative Political Studies* 43 (2010), pp. 230-259.

Thomas, Jo and Ronald Smother, ‘Oklahoma City Building was Target of Plot as Early as ’83, Official Says’, *New York Times* (20 May 1995), accessed at: http://www.nytimes.com/1995/05/20/us/oklahoma-city-building-was-target-of-plot-as-early-as-83-official-says.html?pagewanted=all&src=pm on 2 November 2013.

Valente, Thomas W., ‘Diffusion of Innovation and Policy Decision-Making’, *Journal of Communication*, 43:1 (March 1993), pp. 30-45.

Wain-Hobson, Simon, ‘H5N1 viral-engineering dangers will not go away’, *Nature* 495 (27 March 2013), p. 411. Accessed at http://www.nature.com/news/h5n1-viral-engineering-dangers-will-not-go-away-1.12677 on 27 October 2013.

Wiley, Walt and Herb Michelson, ‘Pieces Missing in Order Puzzle’, *Sacramento Bee* (8 April1985).

Woo, Gordon, *Understanding Terrorism Risk* (Risk Management Solutions). Accessed at http://www.rms.com/Publications/UnderstandTerRisk_Woo_RiskReport04.pdf on 1 November 2006.

Theses

Bloomer, S., *The History and Politics of the I.R.S.P. & I.N.L.A. from 1974 to the*

Present Day (Unpublished dissertation, Document No. P15575, Northern Ireland Political Collection, Linen Hall Library, Belfast, 1988).

Sawyer, John, *Competition in the Market for Political Violence: Northern Irish Republicanism, 1969-1998* (PhD diss., Georgetown University, 2010).

Reports

Abadie, Alberto and Javier Gardeazabal, 'The Economic Costs of Conflict: A Case-Control Study for the Basque Country', *National Bureau of Economic Research Working Paper 8478* (2001).

Ackerman, Gary and John Sawyer, *Embracing Technologies of Lethality* (College Park, Maryland: START, 2012).

Ackerman, Gary, 'Understanding Terrorist Innovation through the Broader Innovation Context' in Maria J. Rasmussen and Mohamed Hafez (eds.), *Terrorist Innovations in Weapons of Mass Effect: Preconditions, Causes, and Predictive Indicators* (Defense Threat Reduction Agency, Advanced Systems and Concepts Office, Report Number ASCO 2010-019, October 2010).

Ackerman, Gary, et al, *Assessing Terrorist Motivations for Attacking Critical Infrastructure,* Report prepared for Lawrence Livermore National Laboratory on behalf of the Department of Homeland Security (Monterey, California: Monterey Institute of International Studies, 2004). Accessed at https://e-reports-ext.llnl.gov/pdf/341566.pdf on 10 January 2010.

Bale, Jeffrey M., et al, *Ricin Found in London: An al-Qa'ida Connection?* (Monterey, California: Centre for Nonproliferation Studies, 23 January 2003).

Carus, Seth and Raymond Zilinskas, *Possible Terrorist Use of Modern Biotechnology Techniques* (Washington, DC: National Defense University Center for Counterproliferation Research, April 2002).

Committee on Forecasting Future Disruptive Technologies, *Persistent Forecasting of Disruptive Technologies* (Washington, D. C.: National Research Council, 2009).

Cordesman, Anthony, *Preliminary "Lessons" of the Israeli-Hezbollah War* (Washington, DC: Center for Strategic and International Studies, 2006).

Craig, Keith and Ian Geldard, *IRA, INLA: Foreign Support and International Connections* (Institute for the Study of Terrorism, 1988).

English, Richard, 'The IRA's Attempted Murder of Prime Minister Margaret Thatcher' in Maria J. Rasmussen and Mohamed Hafez (eds.), *Terrorist Innovations in Weapons of Mass Effect: Preconditions, Causes, and Predictive Indicators* (Defense Threat Reduction Agency, Advanced Systems and Concepts Office, Report Number ASCO 2010-019, October 2010).

Hoffman, Bruce, *Terrorist Targeting: Tactics, Trends, and Potentialities* (Santa Monica, California: RAND 1992).

Hoffman, Bruce, *The Modern Terrorist Mindset: Tactics, Targets, and Technologies* (Scotland: St. Andrews University Centre for the Study of Terrorism and Political Violence, 1997).

Horgan, John and Paul Gill, *From Bomb to Bomb-Maker: A Social Network Analysis Model of the Socio-Psychological and Cultural Dynamics of the IED Process.* A Report Prepared for the Office of Naval Research supported by Grant PAGEN00014-09-1-0667 (University Park, PA: International Center for the Study of Terrorism, forthcoming).

Kostoff, Ronald, 'Simulating Discovery' in Klaus P. Jantke and Ayumi Shinohara (eds.), *Discovery Science: Proceedings of the 4th International Conference, Washington, D.C., November 2001* (Heidelberg: Springer-Verlag, 2001).

Larsen, Judith K. and Rekha Agarwala-Rogers, *Reinvention of Innovation: A Study of Community Health Centers* (Palo Ato, CA: Report of the American Institute for Research in the Behavioral Sciences, 1977).

National Security Innovations and START, *New Horizons in Bioterrorism Workshop Report* (Boston: National Security Innovations and START, 17 September 2008).

Rasmussen, Maria J. and Mohamed Hafez (eds.), *Terrorist Innovations in Weapons of Mass Effect: Preconditions, Causes, and Predictive Indicators* (Defense Threat Reduction Agency, Advanced Systems and Concepts Office, Report Number ASCO 2010-019, October 2010).

Saab, Bilal, *Levantine Reset: A New U.S. Strategy for Lebanon* (Washington, DC: Saban Center for Midlle East Policy at the Brookings Institution, April 2010).

Websites

Cascio, Jamais, *Open the Future Blog* (24 July 2006). Accessed at: http://www.openthefuture.com/2006/07/monday_topsight_july_24_2006.html on 2 November 2013.

'Fierce Drug Delivery' (http://www.fiercedrugdelivery.com/).

Other

Ackerman, Gary and Lauren Pinson, *Profiles of Incidents Involving CBRN and Non-State Actors Database – Organizational Coding* (College Park, Maryland: National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2012).

Ackerman, Gary, 'The Theoretical Underpinnings of Terrorist Innovation Decisions', Conference Paper Prepared for the *Swedish National Defence Centre Seminar on Terrorist Innovation and Learning*, Stockholm, Sweden (26 June 2012).

American Broadcasting Corporation (ABC), *Turning Point: The Order,* Documentary, 1995.

BBC Panorama, 'The Nailbomber' (30 June 2000). Transcript accessed at http://news.bbc.co.uk/hi/english/static/audio_video/programmes/panorama/transcripts/transcript_30_06_00.txt on 11 March 2013.

Bitko, Sheldon, *Mercury Tilt Switch,* U.S. Patent 3,978,301, filed 21 July 1975, and issued 31 August 1976. Available at: http://patft.uspto.gov/.

CAIN Web Service, 'Paramilitary Feuds in Northern Ireland—A Chronology of Events'. Accessed at: http://cain.ulst.ac.uk/issues/violence/feudchron.htm on 4 November 2013.

Global Terrorism Database (College Park, Maryland: National Consortium for the Study of Terrorism and Responses to Terrorism (START), 2013). Accessed at http://www.start.umd.edu/gtd on 2 November 2013.

International Cyanide Management Code for the Manufacture, Transport, and Use of Cyanide in the Production of Gold, 'Environmental and Health Effects of Cyanide'. Accessed at http://www.cyanidecode.org/cyanide_environmental.php on 26 October 2013.

Maurer, Stephen M., *The Third Wave*, Video lecture (2005). Accessed at http:www.cs.washington.edu/education/courses/csep590/05au/lectures/slides/Maurer_Sept7.pdf on 10 January 2010.

Oppenheimer, Andy, *30 Years of IEDs: The Operational Art of the Provisional IRA*, PIRA – Lessons Learned Conference (Stockholm: Swedish National Defence College, 17 April 2012).

Rice, Rob S., 'The Peregrinations of the Queen: Technology Transfer in the Hellenistic World', *1996 APA Convention Session on Naval History*, New York Hilton, Regent Parlor (1996).

Stirling Film Television Productions, 'Bombers' (2012). Available at http://www.stirlingtelevision.co.uk/factual/bombers.html.

Sutton, Malcolm, *CAIN Database of Deaths*, 10 December 1972. Accessed at:

http://cain.ulst.ac.uk/sutton/chron/1972.html on 6 October 2013 on 6 October 2013.

Sutton, Malcolm, *CAIN Database of Deaths*, 20 September 1982. Accessed at http://cain.ulst.ac.uk/sutton/chron/1982.html on 6 October 2013